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[OFFICIAL NOTICE.]

Sixth Annual Meeting, Pacific Coast Gas Association.

OFFICE OF THE SECRETARY, OAKLAND, CAL., June 6, 1898.

The sixth annual convention of the Pacific Coast Gas Association, Mr. F. H. Eichbaum, President, will be held in San Francisco, on Tuesday and Wednesday, July 19 and 20, 1898, in the office building of the San Francisco Gas and Electric Company; morning sessions, from 10:15 to 12:30; afternoon sessions, 2 to 4:30. The Board of Directors will meet on Monday, July 18, at 8 P.M., at headquarters, which are hereby established at office of Mr. E. C. Jones, Chief Engineer San Francisco Gas and Electric Company, No. 413 Post street.

Copies of all papers, questions and applications for membership must be mailed to Secretary prior to July 18. Members to whom questions are assigned are requested to send answers promptly.

Papers will be submitted by the following members, on subjects to be announced:

E. C. Jones, San Francisco, Cal.; C. O. Poole, San Francisco, Cal.; John L. Howard, San Francisco, Cal.; O. M. Gregory, San Jose, Cal.; F. Foveaux, San Francisco, Cal.; John A. Britton, Oakland, Cal.; W. M. Parker, Bellingham Bay, Wash.; A. Gutsch, Fresno, Cal. In addition to his address as President, Mr. Eichbaum will continue his "Reminiscences."

Mr. George H. Hollidge, of Merced, Cal., has charge of "Wrinkles," and Mr. John Clement, of Red Bluff, Cal., is directing the "Experiences." It is hoped the members will contribute liberally to both of these departments.

An excursion is arranged for Thursday, July 21, particulars of which will be hereafter announced.

The Secretary has on hand a number of bound copies of the "Proceedings," which are purchasable at $2 per copy.

JOHN A. BRITTON, Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, Pacific Coast Gas Association.

MERCED, CAL., March 11, 1898.

To the Members of the Pacific Coast Gas Association: At the last meeting of the Pacific Coast Gas Association to me was delegated the duty of collecting and presenting any matter, in the shape of original ideas or special devices, which may come under the head of "Wrinkles," to be presented in proper form for the benefit of the Association at the next regular assembly.

Many of our members having charge of gas plants on the Coast have many plans, that are practical, handy and labor-saving, which many others by force of circumstances have never seen, but who, on presentation of the device, drawn and described, or through the medium of our official organ (the AMERICAN GAS LIGHT JOURNAL), would gladly embrace the opportunity, and put into practice a plan very beneficial—which perhaps had been in use in some obscure place many years, used exclusively by one man—that would, when given daylight, benefit the whole gas fraternity.

On reading this communication, please see if you have not forgotten

something in the shape of a "Wrinkle," that is doing good service in your works, that would be of great importance to the Association. Your answer to this will greatly oblige.

GEORGE H. HOLLIDGE,
Editor "Wrinkle" Department.

BRIEFLY TOLD.

THE LATEST ACETYLENE LESSON.—New Haven, Conn., has had another experience respecting the powerfulness of acetylene as an explosive agent; but this time the result was fortunately less disastrous to human life than was the explosion in the Phflegar factory, in New Haven, in the earliest days in this country with acetylene experimentation. On June 10th, an employee (Patrick Lawlor) of the New Haven Rolling Mill Company was occupied in his usual work of running a steam shears in reducing scrap iron to the proper size for its reduction in the melting furnace. Without warning or any sort of indication that danger was near an explosion occurred, quite similar, it is said, to that resulting from the explosion of a steam boiler, the outcome of which was the death of Lawlor, the severe mangling of his assistant (an Italian named Jenanio), and considerable damage to the shears and its fittings. Subsequent investigation showed that the shears, at the time of the explosion, had in its grasp a steel cylinder, ¼ inch thick, the sealing end of which was closed by a heavy brass nut. The cylinder was 3 feet 8 inches long, and about 9 inches wide, quite resembling the vessels in which acid is delivered to retail dealers in mineral waters. The consensus of opinion in and about the mill is that the cylinders (on a good turning over of the scrap pile in the mill four or five other vessels of the sort that exploded were discovered) at one time in their history were used for confining liquefied acetylene, which theory easily explains the explosion. The New Haven *Register*, in referring to the explosion, says: "Some time ago there was an explosion at the acetylene works in Jersey City, N. J. * * * It is thought that some of the cylinders were gathered up by junkmen, bought in as old iron and brought here in one of the cargoes of the schooner *Anna B. Jacobs*, which makes regular trips to the rolling mill with scrap." The lesson is obvious.

FIELD'S ANALYSIS FOR 1897.—With much satisfaction we note the receipt, from Mr. John W. Field, of a copy of his "Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland and Ireland," which analysis has to do with the accounts of the reviewed Companies for the year 1897. It is quite enough to say (and no better or greater meed of praise could be put upon the work) that the same carefulness which has hitherto marked it is quite as evident this year as ever had been shown by it. Mr. Field proposes one departure in his reckonings which volubly speaks for the hold that water gas is taking in England, which departure is best noted by repeating what he says in respect thereto in his preface: "* * * Owing, however, to the fact that the extension of the manufacture of carbureted water gas (no longer for the purpose of enrichment only) has rendered more or less untrustworthy the figures of some of the averages 'per ton,' the compiler has decided to limit, in future issues of the *Analysis*, his comparisons to the figures of the cost of gas per 1,000 cubic feet sold, except in those cases where the actual quantity of coal carbonized has a direct relation to the figures to be compared; as, for instance, the quantity of coke made per ton of coal, or the value of the residuals produced per ton of coal." The accounts are eloquent of the increase in the magnitude of the gas trading of London. For instance, it is shown that the three London Companies made in 1897 a total of 34,324,169,000 cubic feet, which meant an average gain over all, as compared with the output of 1896 (reckoning the gain on quantity sold) of 5.73 per cent. The total number of consumers was 497,113; the number of public lamps supplied was 78,524. But in justice to Mr. Field we may be excused for saying that the best way to understand the value of the *Analysis* is to buy a copy of it.

NOTES.—The consolidation of the gas interests of Allegheny county, Pa., has been completed. The succeeding corporation is to be known as the Consolidated Gas Company, capitalized in $11,000,000, thus denominated: $5,000,000 bonds, 5 per cents, to run 50 years; preferred stock $2,000,000; common stock, $4,000,000. The executive management of the Company is: President, J. H. Reed; Treasurer, T. H. Given; Secretary, P. J. McNulty; General Manager, Robert Young. The present understanding is that a modern plant will be built on the property of the defunct Pittsburg Gas Company.——It is reported that, on July 13th, Messrs. Jas. Moir, Eldridge McFarland, H. C. Jones, John Tracy and Henry M. Tracy will apply to the Pennsylvania authorities for a charter to operate a gas works in West Conshohocken.——At the annual meeting of the Fargo (N. D.) Gas and Electric Light Company the officers chosen were: President, Seth Newman; Vice-President and Treasurer, J. W. Smith; Secretary and General Manager, O. G. Barnes.

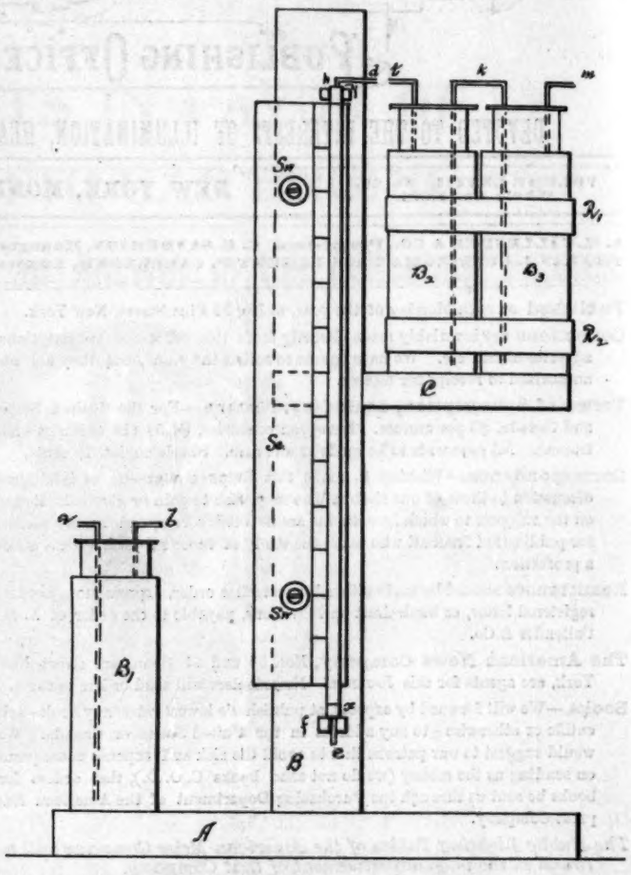
[Prepared for the JOURNAL.]

A Simple and Efficient Gas Analysis Apparatus.

By DR. W. H. BIRCHMORE.

This simple, yet efficient, apparatus for gas analysis is the cheapest one known to me; the first one constructed cost $2.15—considerably less than one-eighth part of the cost of a Hempel apparatus of equal efficiency.

How It Came to be Made.—An acquaintance desired to be in position to make routine examinations for controlling a furnace, and, having been refused by his employer, when he requested him to purchase a



Hempel outfit, applied to me for a design at once efficient and cheap. This cheap construction includes everything essential for Hempel's technical methods by absorption; and with it an accuracy equivalent to one-quarter of one per cent. is within reach.

Description.—The foundation of the apparatus is the piece of wood marked *A*, 12 inches long, 6 inches wide, and 1 inch thick. On this is erected the upright piece *B*, 2 inches wide, 18 inches high and ¼ inch thick. A shelf *C* is fastened to one side of the upright, as shown, and so placed that the distance from the upper surface of the base to the upper surface of the shelf is 10 inches. This shelf may be as thin as is consistent with perfect steadiness; its area is 5 inches square. A cleat secures it. Fastened to the upright are two cleats, *f* and *h*, to hold the burette, which should set out from the upright ¼ inch. The opening in the upper cleat is the full size of the burette; that in the lower cleat the size of the small tube *E*.

The burette can be made more secure by gluing small pieces of cork into the jaws of the cleats after the burette is in place.

The scale was made from one of those cheap rulers, 18 inches long, which can be purchased anywhere for about 20 cents. The end was carefully squared at the first inch mark, and again at the 14th inch mark, giving a seal reading from 2 inches to 14 inches, but 13 inches long. This contained 104 divisions, and the only thing to be remembered was that the divisions were in groups of 8 instead of 10. The eye readily recognized a ¼ part of one division, thus reading to ¼ of 1 per cent.

The burette was a piece of glass tube, about ¼ inch in diameter in the clear, and about 14 inches long. The length was an accident; it might have been anything greater than that of the scale. The cleats would,

of course, be spaced according to the piece of tube used for the burette. *x* and *y* are "one-hole" rubber corks forced into the openings at the two ends of the burette. The lower surface of the upper cork must come a little below the lower surface of the upper cleat, and the end of the piece of glass tube *d* must be just above the surface of the cork. In this way all dead space is avoided.

The zero, the upper edge of the scale, must exactly coincide with the lower surface of the upper end rubber stopper. This was easily adjusted by the screws and washers, marked *Sw*, which allowed considerable room for adjustment, as the holes through the ruler were considerably larger than the screws.

The water bottle B_1 was a common 6-oz. saltmouth, of a sort used for many purposes; these can be purchased at any drug store for a few cents each. *a* and *b* are two pieces of glass tubing about ¼-inch bore. The cork in this case was rubber, as indeed were all used in construction, and they constituted the chief item of the cost. No doubt common corks of good quality, especially if paraffined, would do as well, perhaps indeed better. *b* and *e* are joined by a piece of tubing (rubber, not "vulcanite") 24 inches long, wired securely at both *b* and *e*. A pinch cock is placed on this rubber tube.

The pipettes, or rather the arrangement substituted for the pipettes of Hempel's apparatus, were made of bottles, as B_2 and B_3, of the same size and sort as B_1, corked in the same way with rubber stoppers, two holes. The arrangement of the glass tubes is evident. R_1 and R_2 are rubber bands holding the bottles firmly together; pieces of wood properly shaped acted as separators.

A piece of rubber tubing was wired to *t* and guarded by a pinch cock; when in use the other end of the rubber tube was slipped over *d*.

There might be some advantage gained by slipping another piece of tubing over *m* and closing that with a pinch cock.

Method of Using.—To fill the burette with water: Disconnect any tube from *d*, open the pinch cock on tube *b*, *e*, raise the bottle B_1, turning it upside down. The water will of course rise in the burette driving the air before it until it reaches *d*. To avoid a muss it is well to put a vessel under *d* to catch the drip. By reversing this process, connecting *d* with the gasholder and allowing the water to run back into B_1, a sample of gas can be drawn into the burette.

To take off a sample for analysis, and at the same time to measure it, the following precaution is suggested:

Having attached a piece of rubber tubing to *d*, to connect with the gasholder place on it a pinch cock. Open this and the one on the tube *b*, *e*, and fill the entire apparatus with water by raising the bottle. Next, close the pinch cock on the rubber tube attached to *d*, placing it about ½-inch from the far end. This will insure the retaining of the water. Next, make the connection with the gasholder and draw the gas into the burette until it is about half filled—the rubber tube will then be filled with gas; close the pinch cock as near the end as possible and plunge this end with the pinch cock into a beaker filled with water; keeping the end under water, open the pinch cock. The difference in level will cause the water to rise into the rubber tube as the water in the burette runs into the bottle, and when all the gas is washed into the burette the water will follow, filling tube *d*. Next, close the stop cock on tube *b*, *e*, leaving the other open. The tube attached to *d* can now be removed without danger of loss of sample, which is at this point held secure between the water in *d* and that in the burette.

To pass the gas into the reagent pipette, connect the tube *d* with the piece of rubber tubing fastened to *t*, which should be filled with water from a dropper, and open the pinch cock.

By lifting the bottle B_1, the gas can now be driven over into the reagent holder, and, when the water begins to follow it, the pinch cock having been closed, the gas will be held securely between the water in *t* and the reagent in the bottle.

The Management of the Reagent Bottles.—If the reagent is phosphorus the task is very simple. Remove both stoppers, put the phosphorus in B_3, fill the latter with water and put enough water in B_2 to fill it about one-third full. By blowing into *m* the water will be forced through *k*, and, if the corks are well fitted, all the air and some water will be forced from *t*; then close the pinch cock on the rubber tube which is fast to *t*. If solutions are to be used, fill the bottle B_2 nearly full, and about half fill B_3, then proceed exactly as before.

It was at first intended to use this apparatus only for estimating the amount of oxygen and carbon dioxide in furnace gases, but it was soon found that all reagents which are "absorbents" could be used in it, adding little to the trouble involved. The series of reagents advised by Hempel have all been used with success.

I am informed that with absorbents something is gained by filling the bottle B_2 with glass agates; also that Nordhausen acid can be used instead of bromine water for absorbing heavy hydrocarbons, if corks are used, well boiled in paraffine, instead of rubber stoppers. For this last I cannot answer, but it works well with all the rest of the reagents.

There is an abundance of apparatus in the makers' catalogues, but the great cost is said to stand in the way of its modest employment. I trust this simple little apparatus (so very cheap, if rubber stoppers give place to paraffined corks, and should not cost more than $1.50, with a few cents for contingent labor added) will suggest to many the examinations, which, made daily and the results recorded, will give the data for interesting discussions.

To use it to the best advantage one must have a copy of Hempel or Winkler within reach, but if the price of the apparatus has hindered the extension of original study it need do so no longer. I trust this design, which I am informed has proved of excellent service to one, may be of some use to many.

What Is the Heating Surface of a Steam Boiler?

[Read by Mr. Chas. W. Baker, at the Niagara Falls Meeting, Am. Soc. Mech. Engrs.]

A fact, now generally understood by engineers and all who have to do with steam power plants, is that the power of any boiler, or more accurately the amount of steam which it can furnish in a given time, depends first of all upon its area of heating surface. Of course the amount of steam which a square foot of heating surface will produce varies between very wide limits, and is affected by a multitude of conditions. It is also true that heating surface is no more essential than the means for supplying the heat—that is to say, a furnace of sufficient size and grate surface to burn the fuel, and draft sufficient to supply the furnace with the necessary air. The furnace and the chimney, however, are not necessarily parts of the boiler at all; their function is merely to supply the heat, and the function of the boiler proper is to transfer as much as possible of this heat to the water which it contains. Both the amount of heat which it can transfer in a given time and the proportion of the total heat generated which can be transferred vary with the area of the heating surface exposed. In other words, both the capacity and the economy of a steam boiler depend directly upon its area of heating surface.

Evidently, then, the area of the heating surface of a boiler ought to be determined with a fair degree of accuracy. The designer of the boiler must know it if, with any degree of precision, he is to adapt the boiler to the work which it has to do. The seller of boilers must know it, if he is to be sure of fulfilling his guarantees of capacity or economy, and the purchaser of boilers should know it in order to determine what he is getting for his money. As a matter of fact, a very large proportion of the boilers bought and sold are actually bought and sold by their heating surface. The prices asked for and quoted may be the price per horse power, but the horse power is determined directly from the heating surface, the number of square feet allowed to a horse power varying from 5 to 14, according to the type of the boiler. Again, in comparing the work done by different boilers, the relative heating surface is always taken into consideration.

We need go no further for proof that accurate determination of boiler heating surface is a desirable thing. But we have now to notice the remarkable fact that, in computing boiler heating surface, an error of from 7 to 17 per cent. is made by a large proportion of steam engineers and boiler manufacturers. The error to which we refer consists in taking the surface in contact with the water, instead of that exposed to the fire or hot gases, as the heating surface. If the heating surface is flat, of course the areas are the same; but boiler heating surface is in most cases made up of tubes, and the difference between the interior and exterior surface of a boiler tube is as much as 17 per cent. of the interior surface in the case of a 1-inch tube, and is about 7 per cent. in a 4-inch tube.

The error arises in the first place from a failure to appreciate the fact that the heating surface exposed to the fire is the actual heating surface of the boiler, on which its capacity depends. A clear understanding of this fact is so important, and it has been and is so generally mistaken by engineers and writers of engineering works, that the writer ventures to submit a discussion of the elementary principles on which this assertion is based.

In Figure 1, suppose we have an iron plate 1 inch thick, on one side of which is flowing a current of hot gas at a temperature of, let us say, 1,000°, and on the other side is a body of water in a steam boiler at a temperature of 300° (corresponding to a gauge pressure of steam of about 52 pounds.)

Now the heat in passing from the hot gas on the side of the plate to the water on the other meets with three different resistances as follows:

(1) Resistance in passing from the gas to the surface of the plate.

(2) Resistance due to the passage through the plate.

(3) Resistance due to the passage from the other surface of the plate to the water.

That one of these resistances which is accurately known is (2), the resistance in the passage through the plate. The heat conductivity of metals has been carefully determined by experiment in physical laboratories, so that if we know the actual temperatures of the two surfaces of a plate and its thickness, we can at once determine how much heat is passing through a unit area in a given time. On the other hand, if we know how much heat is passing through the plate, we can determine what is the difference of temperature of its two surfaces. Let us solve an example of the latter sort: Suppose the plate is transmitting heat enough to evaporate 3 pounds of water per hour from and at 212° per square foot of its area, or about the average rate that the heating surface transmits heat in an ordinary stationary boiler. Since 965.7 heat units are required to transform a pound of water at 212° into steam at the same temperature, the plate will transmit $3 \times 965.7 = 2,897.1$ heat units per square foot per hour, or for convenience let us say 2,900 heat units.

New experiments on the conductivity of metals have shown that an iron plate 1 foot square and 1 inch thick, whose opposite surfaces are kept at a uniform difference in temperature of 1° F., will transmit in an hour 473 British thermal units.[1] Hence to transmit 2,900 British thermal units per hour, the difference in temperature of the two sides of the plate will be $2,900 \div 473 = 6.13°$.

I doubt not it will surprise many to learn that so small a difference of temperature between the two surfaces of an iron plate is sufficient to cause so large an amount of heat to flow through it; but the coefficient for the heat conductivity of iron on which it is based is the result of many experiments by the most eminent physicists, and is accepted as correct by the best scientific authorities, and there is no reason to doubt its accuracy.[2]

In studying our present problem, however, the exact accuracy of the coefficient is a matter of no particular importance. We just found that boiler heating surface 1 inch thick, when transmitting 2,900 heat units per hour, will have a difference of temperature on its two sides of 6.13° F. But we never have heating surface of such thickness in steam boilers. The shell heating surface in internally fired boilers is seldom over $\frac{1}{2}$ inch thick. Furnaces and fire boxes are made of $\frac{1}{4}$ inch to $\frac{3}{8}$-inch plates, while tube heating surface is from $\frac{1}{16}$ to $\frac{1}{4}$ inch thick. We see then that the actual difference of temperature between the two surfaces of a boiler tube transmitting heat at the rate already named will be from $\frac{1}{2}$ to $\frac{1}{16}$ of 6.13°, or in round numbers from $\frac{1}{2}$° to less than 1° F. As the eminent physicist Lord Kelvin has said, for all practical purposes, we may consider that the heating surfaces of steam boilers conduct heat as if they were no thicker than paper, or as if the metal were

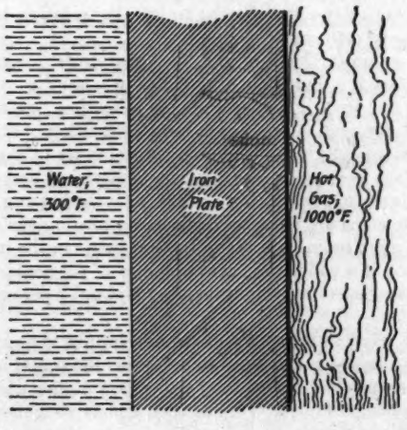


Fig. 1.

of infinite conductivity. It will be seen also that an error of 50 per cent., or even of several hundred per cent., in determining the coefficient of conductivity of iron, even if such an error were probable, would make no practical difference in this conclusion.

There are many facts of practical importance to be drawn from this. For example, in its light we can readily see how little reason there is to expect any greater economy in locomotive boilers with brass or copper tubes and fire boxes than in those of steel. Yet we still hear the superior conductivity of copper urged as a reason why English railways stick to the use of copper fire boxes.

Turning again to Fig. 1, we know now that the two surfaces of the plate (if we conceive its thickness reduced to that of an ordinary boiler tube) will have only a trifling difference of temperature. Next let us discuss the relative heat-absorbing powers of the water on the one side of the plate and the hot gases on the other. It is to be kept clearly in mind that the temperatures of the two sides of the plate which we have just considered are the temperatures of the skin of the plate itself, which is quite a different matter from the temperature of the air or the water in contact with the plate.

If this is clearly understood, it will be easy to understand that the actual temperature of the plate itself depends on the relative heat-transmitting power of the fluids on its two sides. If these fluids were the same on the two sides, and were at the same temperature and under the same conditions as respects mobility, then the plate temperature would be a mean of the temperatures of the fluids on its two sides.

But in the case shown in Fig. 1, since water is many times as efficient as air or furnace gases in absorbing heat, the plate temperature will be nearly the same as that of the water and far below the temperature of the hot gases.

This is a fact which is a matter of common knowledge, and yet it has been overlooked by many engineers and by engineering writers; and because it has been overlooked is one main reason why engineers have not always insisted on the fire side of tubes being considered the heating surface of steam boilers.

Let us review some of the facts which show the relative heat absorbing power of water and gases: Take an iron rod and heat it to redness, then let it be held still with only the air in contact with it, and see how long a time elapses before it is cool enough to be touched. Heat the rod to redness again and then plunge it in water and again note the time before it can be touched. We have then a very rough approximation of the relative heat absorbing powers of air and water.

Again, experiments have been conducted to determine the temperatures to which a metal plate could be heated when one side was in contact with water. The temperature was determined by inserting in it plugs of various fusible alloys, and the fire side of the plate was then subjected to the most intense heat that a powerful blowpipe could produce. So long as the water side of the plate was clean, it was impossible to melt the fusible plugs.[1]

The most striking illustration, however, which the writer has ever seen of the large heat absorbing power of water, as compared with air, was an experiment conducted by him for another purpose some years ago. A vessel having a single vertical tube of about 2 inches diameter was filled with cold water (45° to 50° F.); the hot gases from a large oil lamp or a Bunsen burner at a temperature of some 1,000° or more were then passed up through the tube. The surface of the tube exposed to the hot gases was kept so cold by the water on the other side that drops of dew were condensed upon it from the hot gases, and the interior of the tube became actually coated with dew, which remained until the water was warmed to about 60°. I advise anyone who may not be convinced as to the enormous heat absorbing power of water as compared with gases, to try this simple experiment.

It is very easy to understand why water should have so much greater heat absorbing power than air. The specific heats of water and air are as 1 to 0.23 for equal weights; but since air at ordinary temperatures weighs only $\frac{1}{773}$ as much as an equal volume of water, if we consider a thin film of air in contact with a hot surface and a film of water of equal thickness and area in contact with a similar hot surface, the water would absorb 3,530 times as much heat as the air if the temperatures of each were raised an equal amount. Again, the relative heat conductivities of water and of air, according to Lord Kelvin, are as 40 to 1. On the other hand, in the transmission of heat from a surface to a fluid, the mobility among the particles of the fluid, whereby fresh portions of it are constantly brought in contact with the surface, is a

1. See Ganot's "Physics," 13th ed., page 378.

2. Many engineering text books and pocket books still quote Rankine's formula and Peclet's coefficients for heat conductivity; but the latter have been found by the more careful research of modern physicists largely in error.

1. It may be well to point out that this method of determining the maximum temperature reached by the plate is subject to more or less error on account of the obstruction to the passage of heat from the plug to the metal of the plate (the plug being merely embedded in the surface of the plate and not passing entirely through it.) Any joint between two metal surfaces interferes with heat conductivity just as it does with electrical conductivity. The amount of interference depends upon how intimate the contact is between the metals, the amount of oxides (if any) between them, etc.

matter of great importance, and in this respect air, of course, has a considerable advantage.

The writer has been unable to find any trustworthy figures for the relative heat absorbing power of air and water; and the practical importance of their accurate determination would be trifling, for we know in a general way and from the examples already cited that water absorbs heat very many times more rapidly than air; so many times that in the case of a thin metal plate, such as a boiler tube, transmitting heat from furnace gases on the one side to water on the other, we can be quite certain that the temperature of the metal plate is at most only a few degrees warmer than the water in contact with it.

In other words, in any steam boiler with clean heating surfaces we can assume the temperature of the fire side of the heating surface to be practically the same as that of the water in the boiler. Perhaps it may be 1° more; perhaps it may in some cases be 20°, or possibly 30°, more. The difference is of no practical importance, since in the few cases where so large a difference as 20° or 30° may possibly exist, the temperature of the fire to which the surface is exposed is greater by probably 2,000° or more than the temperature of the plate.

If, now, it is clear that the fire side of the boiler tube or flue is at practically the same temperature as that of the water in the boiler, the reader will have little difficulty in comprehending that this surface, and not the surface on the water side, is the real heating surface of the boiler, which measures its capacity of making steam.

The great resistance to the flow of heat in any steam boiler is in geting the heat from the hot gases into the surface exposed to them. Compared with this, the resistance to the passage through the plate and the resistance to the passage from the plate into the water are mere trifles. If we increase the surface exposed to the hot gases, we shall increase the capacity of the boiler to absorb heat; but if we leave this surface the same and increase the surface exposed to the water, the amount of heat transmitted in a given time will be practically the same.

The case can be made still more clear, perhaps, by an analogy to the flow of water through pipes. If we have a length of 1-inch pipe, connected to two lengths of 12-inch pipe, and allow water to flow through them under a head, it is clear that the flow will be determined by the resistance of the 1-inch pipe. If we enlarge that, we shall enlarge the flow; but if we leave that alone and enlarge either or both the 12-inch pipes, the flow will be practically unchanged.

The area of the fire side of the tube is what determines the heat-absorbing power and the steam making capacity of the boiler. If we can cause this to take up more heat in any way, we shall increase the power of the boiler. The Serve tube, with its ribs extending into the hot gases, increases the interior surface of the tube, and thus its capacity for absorbing heat. If, however, instead of putting ribs on the fire side of the tube, we put them on the water side, we increase the surface exposed to the water, but we make no increase of any practical importance in the amount of heat transmitted. In a similar way, the curved form of the tube, which causes the surface exposed to the water to be greater than that exposed to the fire (in fire-tube boilers), effects no increase in the amount of heat transmitted. The real heating surface, which determines the amount of heat transmitted, is the surface exposed to the fire.

In the preceding discussion it has been supposed that the heating surfaces were clean on both sides. As a matter of fact, heating surface is almost invariably more or less coated with soot or ash on the fire side and with scale on the water side. If the preceding discussion has been carefully followed, it will be clear that the transfer of heat will be much more interfered with by the deposits on the fire side than by deposits on the water side. To use again the analogy of the water pipes, a half-closed valve in the 1-inch pipe would have far more effect than a half-closed valve in the 12-inch pipe. It is no part of the purpose of this paper to excuse lack of care in keeping boilers free from scale; but it is nevertheless quite certain that a thin scale on boiler tubes does not interfere in any noticeable degree with the capacity or economy of a boiler, while the coating of the fire side of the tubes with a flocculent deposit of soot does certainly interfere in a marked degree with a boiler's steam-making capacity. Of course, a thick scale on the water side of tubes or other heating surface, or any other material which acts as a non-conductor, may considerably obstruct the flow of heat. If it does this, the temperature of the heating surface itself will at once be raised, and may reach a point, as happens sometimes with the shells of externally fired boilers and with the furnaces of marine boilers, where the metal may be so heated as to bulge or buckle.

It may be worth while in this connection to administer a puncture to that hoary fraud which has been repeated in technical literature and trade catalogues "*ad nauseam*." I refer to a table purporting to give the loss of economy in per cents. for each $\frac{1}{16}$-inch of scale upon the heating surface of a boiler. In view of the fact that there are many varieties of boiler scale, varying widely in porosity and heat conductivity, and remembering that the thickness of scale in different parts of a boiler is never uniform, it hardly needs the discussion above to show the utter absurdity of this ancient "fake."

Another deduction of practical importance from the fact just set down, is that so far as the transmission of heat after the boiler is making steam is concerned, the circulation of the water in boilers is of a good deal less consequence than has been sometimes claimed. I do not mean by this that it is not worth while to make proper provision for circulation. There are possibly some parts of boilers worked with forced draft, such as the tube plates of marine boilers, where it is so difficult for the steam bubbles to get away fast enough that we have a mass of foam instead of water in contact with the plate. Under such conditions, of course, the plate is bound to be heated; but I know of no evidence that this is any other than a rare occurrence, even in boilers which are pushed most severely. If anyone is inclined to stick to the old hobby that circulation is of great importance to economy, I advise him to consider the conditions in the narrow water space (about 3½ inches wide) around a locomotive fire box, where the steam rushing up is directly opposed by the water going down. Let it be understood that I am referring to circulation only as affecting the transfer of heat and the consequent economy and capacity of the boiler. Good circulation is desirable to prevent unequal heating of the boiler, and consequent straining, and it may be of service in preventing deposits of scale and mud in places where they are least desirable; but that it has any appreciable effect on economy and capacity is not proved, and probably cannot be.

It has been demonstrated above that the surface exposed to the fire is the real heating surface of a steam boiler. Is there any good reason why this should not be generally adopted by engineers as the correct, and the only correct, method of computing heating surface?

The following are some reasons, good or bad, which are likely to be urged against this:

1. The makers of fire tube boilers will claim that this gives the water tube boiler makers an advantage. With the number of tubes in a boiler, of the same length, the water tube boilers can show 7 to 11 per cent. greater heating surface. This is of course true; but is it not an advantage to which the water tube boilers are fairly entitled? It must be remembered that nowhere in this discussion has it been claimed that there was any fixed heat transmitting value for heating surface. On the contrary, it is entirely certain that a square foot of heating surface in one type of boiler may have double the heat transmitting power of an equal area in another. Again, the relative facility with which heating surface can be cleaned of soot and ash counts for a vast deal, more than most steam users are accustomed to believe. It certainly seems that the makers of fire tube boilers have enough valid arguments to offer for their product without demanding the privilege of overstating their heating surface by 7 to 11 per cent.

2. Another argument offered for the use of the exterior surface as the heating surface is that this makes a given boiler show a larger heating surface than if the interior were taken. However much the argument may appeal to boiler manufacturers—and I hardly think they will take it very seriously—it deserves no weight with engineers. A foot rule is no longer for calling it 13 inches.

3. It is urged that practice is and has in the past been fairly uniform in accepting exterior area as the heating surface, and it is best to stick to a uniform practice, even if it be in error, than to change. If the practice were actually uniform, there might be reason in this argument; but while the majority of engineers probably use the exterior surface of tubes in computing heating surface, there is a very respectable minority which insists on the correct method of computation, and this minority shows no signs of decreasing.

4. As the outside diameter of the tube is even inches and the thickness of tubes varies, it is easier to compute the exterior heating surface than the interior. Probably this is one of the principal reasons why the outside surface has so frequently been taken; but in these days of tables and pocketbooks and aids to computations, so trifling a matter as computing the interior area of a tube ought not to be an excuse for perpetuating an error. As a matter of fact, it will generally be less labor to do this than it is to figure the cost of the tubes with the numerous series of discounts which are frequently found on hardware bills in these days.

It appears to the writer that none of the arguments which have been cited in favor of computing the exterior surface of tubes as their heating surface is sound enough to justify engineers in perpetuating this

error. If, however, for the sake of uniformity or ease of calculation it should be thought best to use the exterior surface of tubes in computing heating surface, the fact that this is not the real heating surface ought to be kept clearly in mind. Misconception and wrong ideas on this point have been responsible for not a few mistakes and absurdities in the design of steam boilers.

Gas Works Machinery.

[A paper read by MR. EDWARD A. HARMAN, of Huddersfield, England, before the Society of Engineers, England.]

Gas works machinery is in many respects so closely connected to several branches of engineering as to make it somewhat difficult to distinguish it separately. The more prominent parts of the machinery have been made the subject of many valuable papers read before this Society. This alone renders the idea of producing anything new upon the subject almost beside the question. It is not only the latest idea which is worthy of consideration, but older and well tested systems. By careful consideration of these, improvements are effected which add materially to their efficiency and life. It has often been realized that, by concentrated thought, designs which seemed incapable of improvement have yielded to the touch of ingenuity and adaptation. Under existing conditions of carbonizing coal, many escapes of gas—such as are involved with the lifting of the purifier covers, and from open, catch-purifiers in connection with sulphate and other plants—are entirely unpreventable; while the smoke and steam add to the deteriorating influences. There is also a quantity of purifying material about the works, a portion of which is exposed to the atmosphere for the purposes of revivification. In addition, there is a quantity of waste lime and other material frequently in course of removal. The unloading of coal and the screening and loading of coke also circulate large quantities of dust and grit.

An eminent chemist one day in passing through a gas works with the author, commented upon the objectionable odor he detected, and said he did not mind an equationable one. It is the inequationable gases that have their influence upon the machinery, as well as the others. Lime purification, and especially where the sulphur compounds in the gas are closely dealt with, necessitates the unloading of many thousands of tons of quicklime in the works, the fine dust from which is freely distributed.

Gas works machinery has to deal with numerous combinations of unpurified gases, acids, alkalies, gritty and impure water, oils and spirits. Some of the machinery is required to draw out hot coke from benches of ovens at a distance of from 3 to 4 feet from them, while the machines are subjected to all the influences of heat from the furnaces and material they are employed upon. The machinery, therefore, is not working under the same conditions as at other engineering works, where most of the influences named are absent. To meet these special requirements, necessity and experience have designed a whole collection of machinery, which possesses distinct features of interest and importance.

The extension of gas works machinery is not merely an effort to "save another man," or to reduce working expenses. Apart altogether from the delights and fascination of invention, there is, or should be, the additional object of alleviating the more arduous and irksome work of those engaged. The lot of gas workers has been greatly improved by the adoption of machinery. Machinery reduces the actual unskilled labor on the works, but the manufacture and maintenance of it considerably increase the demands for skilled labor, which in itself is a great counterbalancing consideration for the labor market. The very existence of gas works depends on the advance and improvements made from time to time in the machinery and plant.

Mr. John Brunton, a predecessor of the author's at one of the Birmingham gas works some sixty years since, experimented with an ingenious process, which he patented, for continuous carbonization. The bottom of the retort was placed at an incline, and was possibly the precursor of the subsequent inclined retort systems. The coal was propelled in from one end in small charges, the resultant coke dropping out into a water trough at the other. This system has been tried since at various works, under different names, but has not been permanently successful. The most recent attempt at continuous carbonization is that known as the Yeadon revolving gas retort.

Gas works operations are frequently considered as the most exhaustive class of labor. Retort house work is spoken of as though it were considerably harder in every particular than puddling furnaces. If a comparison could be drawn between the operations of matchmaking, phosphorus, chemical works, copper works, mill work and gas works operations, a different idea would at once prevail. Nearly every gas works possesses novelties and ingenuities in machinery, which will well repay examination. In many cases, they consist principally of special adaptations to peculiar circumstances. At all events, one frequently learns from them what to avoid as well as what to adopt.

Gas manufacture is often considered as a purely chemical operation, which, although largely true, does not altogether exhaust the subject. To illustrate the magnitude of the machinery required, a few figures bearing upon the subject will suffice. According to the parliamentary returns of authorized gas undertakings in the United Kingdom, upwards of 12,250,000 tons of coal are carbonized annually. This produces 8,000,000 tons of coke, together with 2,000,000 tons of tar and ammoniacal liquor, and 130,000 tons of sulphate of ammonia; while for the quenching of the coke, 3,000,000 tons of water have to be obtained and distributed. It is not simply the carbonizing stages which have to be dealt with, but also the subsequent treatment of the various residuals and bye-products.

While large gas works are frequently found to be well equipped with machinery, there are many medium sized and small works existing in which much remains to be done. At a not very remote date, gas works machinery was of the most meagre character. Thanks, however, to the enterprise and ingenuity of members of this and kindred engineering societies, such rapid improvements and developments have been effected, that many large gas works have machinery of considerable magnitude and importance. It is to the further employment and adaptation of machinery for all available purposes that gas undertakings have to look in the future for the extension of their operations. It necessarily follows that, with such machinery in use, all kinds of lathes, shaping machines, and tools are required for their proper maintenance. Indeed, the author ventures to think that some of those engaged in what may be termed purely engineering works would be surprised to find the extent to which machinery is required and employed in gas works. The rapid extension of carbureted water gas plants (the gas from which can only be used sparingly), oil gas plants, and the inclined retort system necessarily minimize the quantity of machinery required in gas works; but whether these systems will continue to reduce the quantity remains to be seen, and can only be a matter of speculation.

The central and most important parts of gas works machinery are the exhausters, although they act in the capacity of pressure pumps as well. In the majority of works, the ascension pipes leading from the retorts have arch pipes at the top, which dip into a hydraulic main. In some few works the dip pipes have been abolished, and a dry main substituted. In connection with the subject of exhausters, it may be of passing interest to deal with a common fallacy respecting the function of this little understood portion of the machinery. It is not infrequently supposed that it is the duty of the exhausters to draw away gas from the retorts; whereas the object is purely to reduce the seal upon the dip pipes themselves, and to draw away the gas from the hydraulic main alone, thus leaving room for the newly evolved gas to take its place. As an example of this reduction of seal, suppose a hydraulic main to have a dip pipe sealing to the extent of 3 inches. Upon the exhausters commencing duty with 2 inches vacuum, the liquor in the hydraulic main is at once raised; whereas that in the dip-pipe is depressed to but 1 inch seal, and through this seal the gas bubbles as it is made, practically forcing its passage. It is absolutely necessary that the dip-pipe should be always sealed, as if it becomes unsealed the vacuum is at once put on the ascension pipes; and, supposing the retort lid were open, this would admit of air being drawn up, composed by volume of 80 per cent. of a diluent gas, nitrogen. This would deteriorate the gas to an alarming extent, apart altogether from the danger of forming an explosive mixture. Not only so, but the unsealed pipe would prevent the other pipes in the retort bench having their seal proportionately reduced; hence they would receive undue back pressure, and commence blowing at the joints of the retort lids, etc.

Heavy back pressure on the retort produces deposition of carbon on the sides of the retort. This is a heavy, hard, solid, stone like substance, requiring to be either chipped off with strong bars or consumed away by leaving the lids open, or by any other specially provided means. The deposition of carbon to the extent of 1 inch upon the interior of the retort would seriously affect the heats and the fuel account.

In the early days of gas making, exhausters were not used—the gasholders having to be counterbalanced by heavy weights; but the carbon nuisance became so great as to ultimately lead to the adoption of exhausters. Another evil of heavy back pressure is that the issuing gas, being unable to get away rapidly enough, is detained in the retort with the incandescent coke, and thereby becomes seriously decomposed.

It is a common supposition that atmospheric air is deliberately drawn into the gas at the retorts through the exhausters. To assist purification at a later stage, it is sometimes found an advantage to admit a measured per centage of air, in order to utilize the 20 per cent. of oxygen (by volume) therein for assisting the revivification of the oxide of iron in the purifiers; but on account of the deleterious effect of the nitrogen, it has to be used with the greatest possible care. In my works at Huddersfield, in preference to this, an extensive oxygen making plant is used, constructed under Brin's patents, and possessing many features of interest and importance. Supposing the dip pipes became unsealed when the retort lids were shut, the vacuum would then be upon the retorts direct; and as in the process of time these have cracks in them, the result of such vacuum would obviously be to draw the obnoxious furnace gases from the setting through the cracks, and hence into the gas mains. The producer gas contains usually about 24 per cent. of carbon monoxide and 8 per cent. of carbonic acid gas, while the spent gases, which would probably be those to be drawn in, consist almost wholly of carbonic acid and nitrogen. Apart from the non-luminosity of such gas, the purification required to eliminate it would be disastrous to working expenses. In gas works where the hydraulic main has been superseded by a dry main, a slight back pressure is also necessary on the retorts, or all the serious consequence mentioned would be liable to take place. Apart from these consequences, anything like putting a vacuum upon the ascension pipes would have the inevitable result of drawing up small particles of coal dust and coke, and stopping them up with a hard, tarry substance.

A further function of the exhauster is to force the gas which has been distilled in the retorts through the purifying and other apparatus of the works, and ultimately to raise the gasholders. Here, again, is a common fallacy—viz., that it is the lightness of the gas which raises the gasholders, after the manner of a balloon. Holders constructed of huge framework! In a gasholder of 200 feet diameter, having 8 inches water pressure, the weight of iron represented equals nearly 600 tons. It is necessary that the capacity of the hydraulic main should be of sufficient size to allow all the pipes therein to remain sealed, in the event of the exhauster from any accidental cause ceasing work. In such a case the whole of the gasholder pressure would be at once thrown on to the hydraulic main, forcing the liquor contained therein up the dip pipes to the maximum amount of the resulting pressure. It is this maximum pressure that has to be provided for. A few years since exhausters were commonly driven by pulleys and leather belts; but now in many works they are driven direct from an engine fixed on the same bedplate. Of course, the best form of exhauster is that which runs as evenly as possible and gives the steadiest gauge. It is apparent that any unsteadiness of the engine might produce any or all of the undesirable possibilities to be avoided.

In designing the size of the exhausters, it is not sufficient to take the daily maximum make of gas, and divide it by 24 hours, and so obtain the hourly make. When the retorts are first charged, the quantity of gas travelling forward is more than at any later portion of the process of carbonization. The rapidity of the rate at which retorts are charged both by machinery and with the inclined system, produces a sudden rush of gas, which is very heavy, and has accordingly to be provided for. The high temperature of the gas as it issues from the retorts, has also to be kept under notice, on account of its larger volume at the higher temperature. Excessive speeds for the exhauster should not be adopted, as by so doing the already high temperature of the gas is increased. It seems to the author that circumferential velocity is the correct method for calculating the size of an exhauster; and a good average rate is about 800 feet a minute at the tip of the so-called exhauster blades.

Generally speaking, exhausters should not be constructed to pass more than between 200,000 and 300,000 cubic feet per hour. It is desirable, above that quantity, to put in another exhauster. The gas to be exhausted is unpurified, as the exhausters are generally placed at the outlet of the condensers. There is a large amount of tar, ammonia, and, indeed, all the other impurities, which have to be extracted in the further processes. The tar will, generally speaking, lubricate the exhausters sufficiently; but at times it is found desirable to add thick creosote oil, or a little thin tar, for additional lubrication. Under any circumstances, it is undesirable to use cheap machine oil for this purpose. When the exhausters are used simply for the purpose of delivering pure gas at a considerable distance away from the works, which is exceptional, any good machine oil may be used; although even then it is an open question whether creosote oil is not the most advantageous for the purpose. The engines for driving the exhausters are of simple construction, but necessarily require to be of a strong character, as their duty is severe. Regarding the horse power required for driving exhausting machinery, this varies according to the pressure and circumstances; and it is, indeed, very difficult to fix any approximate rule for the calculation. For many years makers of exhausters have been reproducing, with few important alterations, the familiar form of machine—namely, that of the rotary type, consisting of an eccentric barrel with a double slide. This is being very gradually improved upon. As regards the speed of exhausters, the general idea seems to be that, unless they rotate with great rapidity, very perceptible oscillations are experienced in the vacuum.

In connection with gas works machinery, a larger use ought to be made of gas engines. It is somewhat of an anomaly to be generating steam, necessitating powerful boilers, when there is such an ample supply of gas power always available.

Pumps are required on gas works for numerous kinds of liquids of varying specific gravities, from light volatile spirits to almost solid matter, in the form of tar and pitch, the viscosity of which is very often fatal to the working of ordinary pumps. Pumps frequently have also to deal with cotton waste, small pieces of coke, and finely divided matter, which have got into the liquid in some mysterious manner. There are also great variations in temperature to be taken into account. Sometimes the liquids are below freezing point, and at others at a high temperature. Pumps in many places have to deal with canal water, containing every possible variety of suspended matter. In calculating the requisite pumps, the specific gravity of thick tar, pitch, etc., must be carefully allowed for, and not merely the 33 feet maximum for ordinary water pumps considered.

Perhaps as important a question as any in connection with gas works machinery is that of the most desirable lubricants. In many places machines are subjected to considerable heat, the effect of which, upon oils and lubricants generally, varies. It is not simply a question of volatilization or viscosity, but the question of the different residuals left from the oil has also to be considered. Much of the difficulty experienced with machinery has been due to insufficient lubrication and improper lubricants. In gas works, the coal and coke dust have to be considered, and the sulphurous and other gases attacking every portion of metal for which they have any affinity, it is absolutely necessary that every part of the machinery not at work should be tallowed and greased, to preserve it ready for future service. It is a common error in many works to consider the machines only want overhauling and attention immediately preparatory to re-starting.

Stacking coal by machinery has not yet been largely adopted in the United Kingdom. The unloading of boats by means of grabs, etc., has certainly made a distinct advance. Upon some of the London works there are magnificent installations of work of this character. In May last, at the Institution of Gas Engineers, Mr. Marshall, the Engineer of the Danish Gas Company, described the new coaling apparatus he had erected at the Fredericksberg Gas Works. The machinery consists of six cranes, with steel lifting grabs, each weighing 3 tons; the total dead weight with the load of coal being 5 tons. There are also automatic cars constructed to carry 2 tons, discharging the coal into bins. These six cranes easily hoist 600 tons per hour, or 100 tons per crane per hour. Assuming the cranes work a minimum quantity of 480 tons per hour, this would equal, for a working day of nine hours, a discharge of 4,320 tons. Assuming the cranes to be at work for six months in the year, or (say) 180 days, the total quantity of coal unloaded would be 777,600 tons. Mr. Marshall, however, does not anticipate, during the first few years at all events, that the annual quantity discharged will amount to more than 500,000 tons.

The Temperley transporter is admirably adapted for use under certain conditions, where a system of overhead transportation is required. It was introduced some five years ago, when the portable beam type of transporter was tried with such marked success by the Admiralty for coaling men of-war during the Naval Manœuvres of 1893. Since that time, however, the Temperley transporters have not only been generally adopted for this purpose by the British and other governments, but they have been applied in a variety of new forms for many uses on shore; and they are especially found to offer distinct advantages over other appliances for special purposes. This is the case when a long outreach is necessary, and goods are required to be conveyed to a considerable distance from the lifting point. A special feature of the Temperley transporter is a carriage (or traveler) of simple but ingenious design, working on an elevated truck, and provided with an automatic device by which the traveler is arrested and held stationary while the load is being lifted or lowered, and which also sustains the load while the traveler is moving. The operations of lifting, transporting and lowering the load are effected by the simple action of hauling in and letting

out a single rope. Any ordinary form of winch may be employed for working the transporter. The travelers are made of numerous sizes and patterns, suitable to the work required of them. At the Midland Coal Company's wharf at Woolwich, this transporter is used for discharging the coal from steam colliers on to a coal stack and into wagons. The plant consists of a hollow steel boom, 83 feet long, suspended from a carriage which is traversed along the flanges of an overhead steel girder of 40 feet span, by means of an endless chain laid to a hand crab. After being held in any desired position, the boom is made fast by guide ropes and remains stationary while the work proceeds. The automatic traveler used runs on a swinging track suspended from the boom. It is operated, as before indicated, by a single rope attached to an ordinary steam winch, placed in an adjacent building. The track is fitted throughout its length with steps 5 feet apart, at any of which the traveler can be arrested and the load lowered and deposited without breakage; the entire operation being under the control of the man stationed at the winch. The transporter is capable of making 60 lifts per hour, and the bulk of coal usually lifted in each scoop is 13 or 14 cwt., representing a duty of about 40 tons per hour. This type of transporter, which is largely used for stacking coal, etc., is made in sizes up to 100 feet in length, and to lift up to 14 cwt.

Coke conveying and screening by machinery is attended by many difficulties, the sharp, gritty nature of the material grinding the apparatus used. One of the best forms of coke conveyors in England which the author has yet seen is that designed by Mr. Henry Hack, M. Inst. C.E., of Birmingham. It is in use at the City Gas Works, Swan Village, near Birmingham, and consists of a continuous bucket chain (Hack and Piggott's patent). The coke is conveyed from the cellars of the retort house to the outside of the house, where it drops on to a conveyor placed at right angles, and is quenched. It is then crrried up an inclined conveyor leading into a circular rotary drum placed at a suitable angle, composed of perforated plates having different sized meshes. Underneath this screen are placed two railway wagons, into one of which the dust falls, and into the other breeze, while at the lower end is placed a third wagon, which receives the coke that has traversed the entire length of the screen, not having sifted through the meshes referred to. It will be seen that hand labor is not employed upon the coal from the time it leaves the pit till it leaves the gas works as coke.

On the Continent, one of the best designs the author has seen for coke quenching and conveying machinery, is that by M. De Brouwer, of Bruges. It consists of a chain conveyor placed below the bottom row of retorts, the return chain of which is placed overhead in front of the ascension pipes and supported by brackets projecting from the buckstaves. The conveyor consists of a water trough composed of plates and angle irons, in which runs a skeleton conveyor, consisting simply of two flat link chains, one on each side of the trough, having round bars fixed between them, at a distance of about 2 feet centers. Light tramways with endless rope systems are also successfully employed for conveying coke.

For many purposes coke is required of a small size, and breakers are now extensively used. Formerly the breaking was done by smashing the coke up with a block, or even with the back of a shovel. The smashing of coke in this way involved a serious loss of material. A good form of coke breaker consists of a series of steel circular toothed disks for cutting the coke. The screening is now accomplished by machinery, and where power is not employed there is generally a rotary hand screen used, which answers the same purpose on a smaller scale. By this means hand sieving and riddling are being superseded. The author witnessed a few years since this hand riddling being undertaken by a number of women. Thanks to the progress of civilization, that is altogether a matter of history. The dusty employment of hand riddling is most objectionable to plant on the works; so that any apparatus to do this class of work mechanically is a distinct gain.

Gas engines and tramcar motors may be perhaps regarded as being outside the range of gas works machinery, inasmuch as, generally speaking, they are not used in the course of gas manufacture, although there are works where some of them are. It is, however, a distinct branch of gas engineering; and the use of gas for propelling tramcars has received a great impetus by the success of the Blackpool, Lytham and St. Anne's tramway of about 8 miles. Gas engines are now made as large as 200 to 300-horse power, though the smaller sizes are mostly used.

Great advances have been made in the economizing of fuel for retort furnaces by the use of regenerative settings, and by the employment of hot coke in lieu of cold coke or coal. In some works also, tar and oil are being used for fuel purposes; but they are obviously unsuitable in towns where stringent smoke restrictions are in force. In all large works the retorts are heated by a system of regenerative furnaces, so that there is little difficulty in obtaining suitable heats for properly carbonizing the coal. At a gas works visited by the author a few years since, he was informed that all the coke made was required for heating the furnaces, and, in addition, a small quantity of coal. It is now customary to reckon from 12 to 15 per cent. of the coal carbonized only as being required for fuel, or (say) 23 per cent. of the coke made; the balance being available for sale.

But there still remains much to be done in the matter of economy of fuel. The refuse clinker and ashes usually carted away to the tip contain a considerable percentage of combustible matter. The author has seen upon some gas works open hearths for consuming or reducing the tip refuse, by burning it to as small a bulk as possible. This means a large waste of fuel, which will eventually be realized. It is worthy of note that scarcely any advance has been made in gas fired boilers.

With reference to the purifying apparatus, hydraulic power machinery is increasingly popular. In some cases huge purifier lids, weighing 10 tons and upwards, are lifted by means of central rams having the requisite supply pipe to the cylinder running underneath the bottom of the purifiers. In other cases the pipe is connected through the top of the purifier cover. With this central arrangement the cover remains elevated over the top of the purifier box during the operations of emptying and refilling with the purifying material. This, in some cases, is undesirable, especially where the purifying material has to be unloaded at the sides of the purifier box. In cases where the material is dropped out through openings in the bottom of the purifier box to a cellar below, the objection is not so great. In other cases the purifier lid is externally lifted, and suspended over the purifier box by chains connected to the corners or sides of the covers, according to the design of the framework, the chain being taken up by means of an overhead hydraulic ram. In this case the purifier cover has usually to be traveled upon a huge carriage and suspended over an adjoining purifier. Some very useful forms of lifting apparatus have been designed, operated by manual labor; but this is a slow and tedious process, and cannot be regarded with entire satisfaction. Messrs. John Abbot & Co., of Gateshead-on-Tyne, have made a specialty of hydraulic lifting apparatus of every design, and have erected several of the finest and most satisfactory installations in the world. They have also applied to many works hydraulic power for crane purposes, for elevating the purifying material to different floors. Some of the best forms of hydraulic pumping engines, lifting apparatus and machinery extant are to be found upon gas works for various purposes.

In scrubbers and washers there are shafts, gearing and machinery, either for working the water distribution gear, or for revolving plates and discs in connection with the apparatus. Many gas valves are elaborate pieces of mechanism. There are also several gas regulating governors, jet photometers and meters, possessing features of interest, although not coming within the scope of this paper.

Mechanical engineering has a splendid field still in gas works machinery to prevent waste. One item alone demonstrates this. The large quantity of gas wasted when the retorts are open, both during the charging and discharging of them—although enormously reduced by the substitution of machinery and inclined retorts in lieu of hand stoking—still leaves much to be improved. The quantity of spent lime, which is in many towns a waste product, also demands further inquiry as to its adaptability or suitability for any other purpose or process. There can be little doubt that with the progress of science, what is now termed refuse material will be turned to profitable account. After calcining the spent oxide at the chemical works for the extraction of the sulphur, the huge heaps of material left certainly ought to be further considered. The broken retort material is now being reground by fire goods manufacturers, and need not be carted away to the tip.

Considering the quantity of fine dust produced from coke, consisting of the best fuel material, it is somewhat surprising that greater attention has not been given to the manufacture of briquettes. Experiments have been made from time to time by the addition of varying quantities of pitch (some 7 or 8 per cent.), and other matter to the dust, but nothing very perfect has as yet been extensively adopted. While coal sludge seems to have made greater strides and with a large amount of success, especially where the fuel has been used for marine purpose, coke dust is regarded as a source of annoyance instead of profit. It has certainly been utilized for asphalting.

The waste water from sulphate of ammonia manufacture deserves consideration. It is now passing away to the extent of millions of tons annually, quite hot. The waste of this hot water should be preventable. Water used for quenching coke is allowed to drain away to

waste, containing, as it does, many different elements in solution. An enormous quantity of cyanides in coal gas is also being lost, although efforts are now being made to recover it.

The retort house is obviously the foundation and commencement of gas works operations, and specially designed machinery for emptying and filling the retorts first claims consideration. Formerly the larger coal required to be broken was dealt with solely by hand. In works now, where hand stoking continues, the stoker is provided with a sledge hammer to smash up the large lumps of coal. Where a large quantity of cannel coal was used, it was necessary to employ a gang of men for the purpose; and as it was desirable the percentage of cannel should be continuous, this gang took their turns as regularly as the stokers themselves.

Coal breakers are generally and most desirably placed, where circumstances permit, in the coal stores, in brick pits covered by suitable iron framing and floor plates. The breaker is driven by a steam or other engine combined with it, or a separate gas engine may be used for driving the breaker where available. There are several sizes and types of coal and cannel breakers to suit all classes of large and small cannel, as well as the numerous varieties of common coal. The coal may be brought into the coal stores by railway wagons on an overhead railway, or by carts or conveyors.

In one of the Birmingham Corporation Gas Works, of which the author had the superintendence for several years, specially designed steel hopper wagons (Hunt and Shackleford's patent), with sloping ends and two sliding doors underneath, were placed directly over the top of a hopper supplying the coal breaker, and the contents of a 10-ton truck were emptied directly into the hoppers and coal breakers below. These wagons were first adopted by Mr. Charles Hunt, M. Inst. C. E., at the Windsor street gas works, Birmingham.

When the cannel or coal has been reduced to a suitable size by crushing through the breakers, it falls, together with the smaller pieces which do not require breaking and the dust, into the bottom of the pit in which the elevator runs. It is then carried up to a large overhead hopper placed in the upper portion of the retort house, on girders spanning between the coal store and the retort bench. These elevators consist of malleable iron buckets fitted to a strong detachable link chain, provided with lugs for fastening the bucket bolts and sliding pieces to. The chain and buckets are guided by a strong latticed iron and steel framing, complete with standards and other attachments for fixing to the coal breaker floor, and also to the overhead fixed hoppers. The elevators are driven by belting and chain gear, with intermediate counter shaft from the coal breaker engines. In cases where the coal stores are only on one side of a retort house containing through retorts, the coal is conveyed to the hoppers by horizontal conveyors fixed over the retort bench. Horizontal and slightly inclined conveyors are also extensively used for conveying coal in this way, as well as from the stores, when situated at some distance from the retort house.

At the present time there are hundreds of gas works with stoking machinery installations in operation, the perfection of which leaves scarcely any room for economy by the more recent invention, or re-introduction, of inclined retorts. With machinery, a retort may be discharged and recharged in a few seconds with comparative ease. Manual drawing and charging machines are applicable to small works having an annual consumption of about 2,000 tons of coal; but the more comprehensive systems driven by compressed air, or by hydraulic power, are suitable for medium sized and large works. The present method of carbonizing coal is in small quantities, of from 6 to 8 cwt. perhaps as a maximum, per 20 foot retort. The three systems of charging the retorts at present in existence are hand stoking, manual or power machine stoking, and the inclined system. The system of inclined retorts necessarily requiring little more than elevators and conveyors does not reasonably come within the scope of this paper; and, tempting as the subject is, it must be left out of consideration.

Hundreds of stoking machines are now giving entire satisfaction in London and the provinces, as well as on the Continent. By the rapidity of charging, the consequent saving of heat in the retort, and the even distribution of the coal inside the retort, an increased volume of gas per ton is obtained. There is also the more important consideration of a reduction in labor and cost of working. With the aid of machinery the coal is broken to a regular size, and is evenly charged throughout the entire length of the retort by the chargers. It therefore follows that a greater quantity of coal can be carbonized per retort than is the case with ordinary hand labor. Very important advantages accrue from the foregoing facts, inasmuch as they not only enable more coal to be carbonized per retort, and a greater volume of gas to be produced (due, as stated, to the even deposition of the coal), but there is also a considerable saving effected in capital expenditure on plant, due to the extra manufacture from a given retort area. This saving goes a long way towards recouping the capital expenditure on the machinery.

The two principal systems now in use are the West and the Arrol-Foulis. The machinery designed by Mr. John West has now been in successful operation for about a quarter of a century. Mr. West's manual type of charging machine consists of a square, upright frame on wheels, traveling on tram lines laid in front of, and parallel to, the retort bench. The machine is propelled by a hand wheel and gearing attached to one side of the machine, and on the opposite side there is another hand wheel and gearing for hoisting and unloading an adjustable coal hopper from one tier of retorts to any other. The adjustable coal hopper on the charging machine receives its supply of coal for a number of retorts from the overhead fixed coal hoppers, and is free to move vertically between the four uprights of the charging machine frame, being guided by them and suspended by chains. A light frame is suspended from the coal hopper for carrying the charger when it is out of the retort. At the bottom of the hopper, but directly over the charger, is a feeder box for supplying the charger with coal. The charger consists of a light carriage, running on three wheels, having two semicircular scoops at the bottom. The scoops are arranged to turn over in opposite directions by the twisting of the long driving rod about half way round in one direction. It will be noticed that this manual charger is designed to charge half the length of the retort at a time and goes in the retort twice to make a complete charge. A removable platform is used for working the top tiers of retorts. Mr. West's manual drawing machine is similar to the charger. With the manual machinery, 45 retorts can be charged and drawn as regular duty in 45 minutes—and this without causing the men half as much fatigue as the ordinary hand labor work involves.

The compressed air system is the one now applied to Mr. West's power machines. After something like 17 years' use of this power, the excellent working results have fully justified its employment. Cotton and wire rope driven machines are at work, with excellent results. The ropes are overhead and are driven by a stationary steam or gas engine, fixed at one end of the retort house. These engines for the driving of stoking machinery are preferably arranged in a house detached altogether from the retort house, as it is most undesirable to have such engines working in dust and dirt, when avoidable. After numerous experiments with gas engines fixed on the machines themselves, it was found undesirable to adopt gas power at all, unless the engines were quite separated from the retort house; and it was, therefore, arranged to drive overhead ropes for the system, or to drive an air compressor for the compressed air system only when arranged in buildings quite removed from the dust and dirt of the retort house. The air is compressed to the comparatively low pressure of 60 pounds per square inch, and conveyed to the required machine by a flexible pipe, with connections and gearing so arranged that little, if any, attention is necessary from the attendant.

The time taken for supplying coal to the charger, and completing the full charge in the retort, averages 30 seconds per retort, or at the rate of (say) 120 retorts per hour. Taking the time from the commencement of a draw to the completion of the last charge, and bringing the machines back into place ready for the successive draw, these machines work 80 retorts per hour. Indeed, this rate has often been exceeded. Before the power machinery was employed the retorts were charged with 6½ to 7 cwt. of coal, which was carbonized in 4 hours 48 minutes. The power machinery puts in 8 cwt. per retort, which is carbonized in the same time as formerly, and which equals about 16 per cent. increased weight of coal alone.

The power charging machines are fitted with propelling gear, for traveling up and down the retort house. Each machine has an adjustable coal hopper, which is raised or lowered to suit the various tiers of retorts, by means of gearing worked by the same motor propelling the machine. The hopper is provided with a feeder box, for regulating the weight of the charge of coal. The charger which enters the retort is carried in a frame suspended below the hopper, and is driven in and withdrawn from the retort by a compressed air cylinder, rack and pinion chain drum, and chains. The charger consists of a scoop and carriage, containing the apparatus for emptying the coal out of the scoop, and replacing it for a fresh supply. The scoop enters each retort twice for making a complete charge—first turning over in one direction and then in the other, thus throwing the coal towards the right and left hand sides of the retorts respectively, which insures the charge depositing evenly over the whole base of the retort. The drawing machines are fitted with traveling and hoisting gear, for raising and lowering the rake bar frame, carrying the rake bar and head to the several

tiers of retorts. They are fitted with compressed air and controlling cylinders, rack and pinion chain drums for the various operations.

The air is conveyed from the receivers by iron pipes to the hose drums, fitted to the girders carrying the overhead coal hoppers. There is generally a large hose drum, complete with all fittings, for each of the charging and drawing machines. A long length of flexible hose is attached to each of these drums at one end, and at the other end to the machine supplying it. Each drum is provided with a hollow shaft, through which air is supplied; and by an arrangement of gun metal swivel joints the air is supplied to the hose on the drums during their revolutions. On each of the hose drum shafts a chain drum is keyed, while a chain attached to this leads over pulleys into the retort house roof, having weights at the other end which rise and fall as the hose is automatically given in and out by the machine as required. The hose leading from the drums to the machines is specially designed for conveying air. It is supported at intervals by suspending brackets and rollers, so that the strain on the hose is very light. The exhausted air assists materially in the ventilation of the retort house.

The Arrol-Foulis hydraulic stoking machinery has many points of interest, requiring similar coal breaking, conveying and elevating plant, as the machinery already described. The charging machine obtains its supply from the overhead coal hopper. A small quantity of coal is dropped in front of the pusher plate, which is then propelled into the retort; the coal being delivered by about half a dozen propulsions, beginning from the farthest end of the retort and receding to the mouth. The apparatus for this work consists of a horizontal slide beam on which are placed two hydraulic rams—one for the forward movement to the pusher plate, and the other for withdrawing it. Alongside the forward or pushing ram is a turning shaft carrying a series of stoppers, which come into operation as the shaft is revolved, bringing the pusher plate to a stand in the successive positions of its stroke. The coal feeding gear consists of an open drum divided into segmental compartments, revolving underneath the coal hopper, and put in motion at regular intervals by means of a hydraulic ram and rack. The action of the drawing machine is so similar to that of the charger that it need not be described. The working pressure usually adopted for this hydraulic machinery is about 400 pounds per square inch.

It is sometimes considered that the depreciation of gas works machinery is necessarily much greater than in other engineering establishments. With proper care and attention, this, however, should not be the case. Every wearable part of any of the machines has to be renewed from time to time to keep it in working order, so that, although the wear and tear are greater, the machine itself remains in as fair a condition as machinery elsewhere. As an illustration of this, it may be remarked that the author has worked exhausters of the Jones type (which consisted of two rollers of a figure 8 section, and which were 50 years old) for many years with considerable success and equality of vacuum.

The quantity of dust in a gas works, especially upon the sidings, and in and about the retort houses, is very great. The type of locomotive is therefore a consideration. Mr. S. Geoghegan's patent shunting locomotive engine is peculiarly adapted for these conditions for narrow gauge railways. The working parts of the engine are boxed up on the top of the boiler, and are, therefore, clear of the liability to be cut by coke dust and grit, as is so often the case when the working parts are under the boiler.

The author considers the foregoing remarks will prove conclusively that rule-of-thumb methods as far as gas works machinery is concerned are being rapidly superseded by mathematical calculation and design, which to all engineers must be a matter of satisfaction.

Public Lighting in Relation to Public Ownership and Operation.

[A paper read by Mr. Alexander Dow, at the Chicago meeting of the National Electric Light Association.]

This paper is written to set before the Association a proposed policy. It is not a new policy in its parts, neither is it an untried policy. It is applicable immediately to public lighting; that is to say, to the lighting of streets and public places under contract with, or on account of, a municipality. Ultimately its application may be more extensive.

It is the belief of many members that the National Electric Light Association should formulate and publish a well considered method of dealing with this business. While local conditions differ, there is no local difference in the principles which should govern electric lighting companies in their dealings with municipalities and municipalities in their dealings with electric lighting companies. An authoritative statement of these principles is needed. A statement by the Association may be accepted in the first place only by the electric lighting companies, but if the principles so stated are intrinsically correct, their acceptance by the municipalities must follow. No city government will persist in a course that is plainly inequitable.

In the history of street lighting by electricity no chapter contains more profitable matter of study or for illustration of general principles than that which contains the record of the city of Detroit. That city was one of the first to use electric lights on its streets. It began in 1883 with 22 arcs, and in 1884 abandoned all other street lights. This street lighting business was believed by those who first engaged in it to be a monopoly secured by patent rights; they found their mistake after much money had been invested under that belief; competition ensued, then consolidation, and finally municipalization of the service.

In February, 1896, the city of Detroit owned 1,500 arc lamps and was operating 1,492 of these in the work of street lighting. In the same month the successor of the Brush Electric Light Company, which installed the original 22 lamps in 1883, and which, until 1890, lighted the streets under contract, owned 1,049 arc lamps, and used in private lighting 433 of that number. Another company, organized in 1890 to compete with the Brush Electric Light Company, owned 1,330 arc lamps, and was using in private lighting 38 of these. In each case there accompanied the arc lamps a sufficient number of dynamos, engines, boilers, etc., and a building fully equipped for the operation of the number of lamps stated. At the same time the city had in use 134 towers, which had been formerly owned by the Brush Company, and the other company was in the act of taking down and removing from the streets 104 similar towers, which had formed a duplicate of the Brush Company's equipment. The necessary lines to connect lamps distributed over a large city had been owned by all three. The city had in use 329 miles of overhead wires, connecting to its 1,492 lamps. Neither of the companies had owned such a great mileage of line, but one had taken down lines and poles which had supplied 719 lamps, and the other was in the act of removing lines and poles which had connected in 1,279 lamps.

Some of the Brush Company's street lighting equipment had been during the preceding five years diverted to the supply of commercial lights. Nevertheless, two-thirds of that equipment is to the present day a useless asset. Lamps which were bought at $40 have proved impossible of sale at one-tenth of the price. Dynamos which cost $2,400 cannot be sold to-day for $240. Lines taken down returned only a small percentage of their cost to the treasury. The towers which this Company sold to the city did not bring their original price—that goes without saying—but they brought a fair price.

The loss of the second Company was greater. Changes in the business had made their street lighting arc lamps unavailable for commercial use, or almost entirely so. Similar changes had made their dynamos a slow asset. The engines were partially diverted into commercial service and the boilers entirely so. The wire taken down was not of a size that would fit in to their commercial lighting system, and the poles hardly paid for the labor required for their removal. The 104 towers—one of the heaviest of all the original expenses—had to be sold as scrap iron.

It is clear that a loss to some person or persons was involved in conditions which reduced machinery and lines capable of supplying over 2,000 arc lamps to approximately their junk value. Leaving out all questions as to personal fault—neither affirming nor denying that the loss fell upon those for whose economic blunders it was the inevitable punishment—it is certain that there was a loss to the community at large; that property which might have been and which had been capable of doing good service to the public was as surely destroyed as if it had been swept out of existence in a great fire.

It may be asked on whom did the loss fall. In social economy the loss of one is the loss of all, but to our customary modes of thought there appears a difference between losses borne by ourselves immediately and those which are apparently borne by other people. In this case the greater part of the loss was borne by business men of the city of Detroit. It was a reduction of the available capital of men engaged in productive industry in the city. This reduction—this absolute loss—after correcting for inflated values which should have been written off long before the period of liquidation; after correcting for securities issued for cash at less than their face value, or for considerations which were valued at more than their true worth, was not much less than $400,000.

I do not ask you to sympathize with the immediate losers, but I ask you to remember as my argument proceeds that this loss came about in consequence of business methods and of social tendencies which are in active operation to-day in nearly every town represented in this Asso-

ciation. And I submit as a principle not admitting of dispute that the duplication of an effective equipment for public lighting is an economic error, entailing loss of available capital to the extent of the duplication.

In the absence of some other acceptable means of setting a proper price for public lighting by contract, public opinion will not tolerate the suppression of competition.

Would the public of Detroit, after the agitation for municipal ownership had become general, have approved of award of a contract at a low price, or would it have insisted on municipal ownership as a matter of principle? An answer to this is merely an expression of opinion, but I believe that had a low price been offered the agitation for municipal ownership would have been suspended and that the companies might have secured terms more to their interest than was the action actually taken.

There is no longer any question of the right of a municipality to own and operate its own public lighting plant. Electric street lighting is a distinctly public service, which must be provided for by the municipality. It is a service to every citizen; is a sequence of the social conditions which constitute city life as distinguished from rural life, and can only be effectively performed on municipal account and under municipal control. Herein it differs from the electric lighting of private premises, and it is necessary to note the difference. Electric lighting is the cheapest as well as the best light for streets and public places. For private premises, on the contrary, electric light is not a cheap light under usual conditions. It is not now, and is not likely to become, an illuminant of universal use, to the exclusion of gas and oil. Why this is necessarily so is well known to the members of the Association. To the general public it is a statement better proven by a couple of good examples than by a long statement of causes. In the city of Detroit there were, in 1897, according to the annual report of the Water Board, 54,945 "families." There are in the city of Detroit approximately 18,000 customers for illuminating gas and 4,000 customers for incandescent electric light. It is safe to say that the remaining three fifths of the possible customers use kersone oil. The main cause of the use of oil is its lower cost.

The city of Glasgow, Scotland, owns and operates its gas works and owns and operates its electric lighting plant. Neither of them is intended to make a profit. The Glasgow price for gas is 53 cents per 1,000, and the Glasgow price for incandescent lighting is equivalent to gas at $1.35 at the maximum rate, and 56¼ cents at the minimum rate. I think this example from a city where municipal ownership has been most thoroughly exploited, and where the municipal management is above suspicion of inefficiency or corruption, proves beyond question that electric lighting for private use is a luxury, and as such must continue to be used only by those who can afford luxuries; that is to say, by a minority of the citizens of any municipality; not by a majority, much less by every citizen.

Therefore, while it is admitted that the lighting of the streets is truly a public service, which may be performed by the municipality for and on behalf of every citizen, the furnishing of electric light to private consumers is not a public service, but is essentially a service to a few individuals, and as such should not be undertaken by a municipality whose object is to perform only those duties which municipal society as a whole owes to itself as a whole. This principle should be clearly understood, and should be boldly maintained. It is necessary that a municipality shall undertake certain services, and it is possible that it may undertake others, but the propriety of its undertaking any service depends on whether that service is to the public or to individuals; to the many or only to the favored few.

This leaves to private enterprise the supply of electric light to private consumers. In performing this service there will be built and equipped a power house; there will be organized an operating and a managing force; there will be constructed lines of distribution. All of these may be, and part of them certainly will be, adapted to the performance of public lighting, in addition to the service of private consumers. To whatever extent this double adaptability exists in the private plant, there will be duplication of equipment in any other plant separately established for performance of the public work. Moreover, it is peculiarly characteristic of public lighting operated all night that its addition to the ordinary work of a private lighting plant tends to reduce the average cost of the combined output. In these considerations rests the possibility of a contractor profitably performing public lighting for a city at or below the price at which the city can itself do the work, and yet it being to the interest of the contractor to undertake the business.

Let us for a minute assume that municipal engineering and management and municipal financing can be just as good as private engineering and private financiering. If they are not so, it is the fault of the municipality, because technical and financial skill and executive ability are for sale in the labor market and are purchasable by a municipality, even as they are by private employers. There remains only one evident cause which should tend to make the costs of a municipal plant differ from that owned by an individual or a company. That difference is that the individual proposes to make a profit and the municipality does not. Looking closer at the facts, we find that the municipality must in most cases allow the equivalent to a profit, because a municipal plant is built by money borrowed at interest. In the case where the money is not borrowed, but raised by direct assessment, the municipality has prevented some of its citizens from profitably using the money taken from them by taxation to be invested in the lighting plant, so that even in the exceptional case the possible profit to the tax payer on the money withdrawn from his business had to be considered. But the rate of interest on municipal bonds is usually less than the rate of profit which a private owner is willing to accept on money invested in the electric lighting business. It is 4 per cent. as against 6 or 7 or 8 per cent. In the final analysis the difference between the cost of lighting by contract and that of lighting at cost by a municipally owned plant should not exceed 4 per cent. on the capital invested in the plant. I assume in making this statement that the rate of interest on city bonds is a fair measure of the profit that investors expect on a secure investment. If the investment in an electric lighting plant were equally secure, the rate of interest necessary would be no greater. The security depends so largely on the policy of the municipal authorities that it may approximate to that of municipal bonds on the one hand; or, on the other, it may be of the same order as the stock of a speculative gold mine or a Klondike expedition. In saying that the difference should not exceed 4 per cent., I am to be understood as implying such conditions as take the investment out of the speculative class. I am also to be understood as implying that proper salaries for management have already been paid out of earnings, and that the profit mentioned is that payable to capital alone; in other words, an exact parallel to the payment of interest on a municipal bond.

It follows that if the organization and equipment of an existing plant engaged in the supply of electric light to private consumers are available for the purpose of performing public lighting, this maximum difference of 4 per cent. can be thereby reduced, or even reversed. In every case the difference should be reversible. There are causes to be considered later which tend to the contrary, but the fact remains that there is no irremovable cause why an existing electric lighting plant should not be able to perform public lighting at a less price than the municipality can do the work itself.

Of the causes which tend to the contrary, one is that the plant which has a contract for public lighting may have very little private service, or none at all. Some other plant in the same city may do all or most of the private business. This condition of affairs can be only temporary. The consolidation of the two plants is an economic necessity, certain to arrive in time. The only condition justifying the existence of two plants in the same city is that the city is so large as to make a division of territory desirable; and even in that case an operating agreement is to be preferred to complete independence.

The public has been told that consolidation of plants is not to the public interest. This is an error, and the way to prove it such is to give to the public the surplus profit of consolidation in the shape of lower rates or better service—either or both.

Another cause tending to handicap the contractor is that few municipalities will make contract for a long term of service. Even the advocates of municipal ownership who are willing to issue 20 or 30 year electric light bonds, and who will not write off more than 3 or 4 per cent. for depreciation of plant in making their estimates of city operation, will protest against a contract running more than a year or two. They claim for the municipal plant all the advantage of a secure investment, and simulteneously deny these advantages to the contractor. We know that the securing of a long-term contract permits the installation of the most economically operated machinery, and reduces the percentages of profit, which must be earned annually. The objection to the long contract, that it denies to the city any share in the profits of possible improvements effected during the term of the contract, can be met by so drawing the contract that the margin of profit shall plainly be reasonable to begin with, and that the city may share in the results of improvements in consideration of guaranteeing a similar reasonable profit on the investment to be made in such improvements. A 10 or 20 year contract with such a clause could be safely taken at a very low price.

A possible solution of this problem is city ownership of the plant, combined with operation by a contractor. I think that this plan may

by and by become ecmmon. It involves too many details to permit of my discussing it at present.

The very worst handicap that a contractor may have to carry is excessive capitalization. Here it must be noted that many municipally owned lighting plants do not report all their capital expenditure, so that in carelessly made comparisons of fixed charges the contractor appears to have overstated his investment in order to increase the apparent cost of operation. Any comparison must be on an identical basis for capital as well as for operating charges. And for the purpose of adjusting prices between municipality and contractor, only one basis for capital charge is acceptable; namely, the present value of the plant—in brief, a properly made inventory. This proposition is so radical that I state the reasons for it.

The possible bases for a capital charge are as follows: First—The face value of the securities issued by the plant. That this is an impossible base of adjustment is too well known to all electric light men. Second—The current market value of these securities. This is impracticable, because many securities are not on the market, and because the immediate earning capacity of a plant affects the price of its securities, and because—last, but not least—some securities are speculative rather than industrial. Third—The actual cost of the plant. This would be proper if all plants had been built at the same time and if no plant had been obliged to be rebuilt. As it is, the construction cost of two plants built, the one in 1888 and the other in 1898, the two of identical capacity and of similar type, may be to one another as two to one; the earlier plant may have cost twice what was paid for the later, solely because of the reductions in the prices of machinery and material of construction in the last ten years.

The only remaining possible base for a capital charge is the present value of the plant, and I do not think that any other can be made acceptable for the specific purpose of adjusting a price for public lighting. It does not follow that the capital account is to be readjusted to a corresponding figure. It is only requisite that the company accept as a proper profit on public lighting business an allowance based on inventory value of the investment. It would be well for the industry, however, if all our capitalizations were brought near to present values. And one good result of revaluation would be a logical sequence—the depreciation of the investment from year to year would necessarily be admitted as a proper charge against revenue. If a profit is only to be allowed on capital sufficient to construct a plant at the comparatively low construction prices now ruling, any further decline in cost of construction must be considered an impairment of capital, to be made good before any profit can be paid. It is not to be understood that I expect an electric lighting company to stop dividends or to reduce capital stock in order to make good in any one year an extraordinary depreciation charge, due, for instance, to the replacement in the year of old type machinery with new, in order to meet a public demand for a higher grade of service. Such extraordinary charges must be financed according to well understood rules. The loss of value of the old machinery does not occur in an instant, but is a process continuing through several years. So far as it is possible, this loss of value should be anticipated by charges made in advance—in other words, by the accumulation of a renewal fund. But where this has not been done the charges should be distributed over a proper period with due regard to all interests involved—in other words, so as to secure the greatest good for the greatest number. The principle is all important. The detail as to how a proper depreciation charge shall be put on the books is a matter to be disposed of in the most convenient manner.

Having recited my premises, I now state my proposed policy as a recommendation, as follows:

I recommend that the Association declare by resolution—

1. That a municipality may properly provide for public lighting either by the ownership and operation of an electric lighting plant, by the operation of a contractor under lease, of a municipally owned plant, or by contract with the owner of a private plant.

2. That the supply of electric light to private users is not properly a municipal function.

3. That the performance of public lighting under contract by a private plant in connection with the supply of electric light to private users is essentially the method of least expense.

4. That the existence of two electric lighting plants in the same territory is an economic error, tending to increase the cost of production, and thereby the selling price; and that the maintenance of competition is to the detriment of the public.

5. That public lighting by contract should be performed at the lowest price consistent with a reasonable profit on the value of the investment; that no electric lighting contractor should demand more than such a profit, and that each municipality should protect the contractor in the enjoyment of his profit, and against impairment of his investment, in order that a minimum profit may become reasonable.

6. That in order to adjust prices in the absence of competition it is necessary that costs be ascertained and prices approved by a competent authority, acceptable to the public as well as to the contractor.

7. That in the absence of a constituted authority competent to ascertain costs and prescribe prices, members having public lighting contracts under consideration should endeavor to have the adjustment of the contract price undertaken by a temporary commission, or arbitration committee, who will adopt as the basis of adjustment the principles set forth in these resolutions, particularly in resolution No. 5.

8. That there is no essential difference in the organization of municipally owned plants requiring a different analysis of costs from that which is proper for private enterprises, and that the publication of the costs of municipal lighting plants properly analyzed is beneficial to the electric lighting industry. Further, that the similar publication of the costs of private plants is desirable, but is at present impossible, because of its advantages to actual or possible competitors.

In conclusion, I desire to say that the tendency of public opinion appears to be toward some interference by and on behalf of the public with corporations performing so-called public services. Such a tendency is a concomitant of our social progress. It is not merely a temporary surge, but is a part of a general movement. It cannot be withstood, but may be guided into proper channels. The general result of any such movement is for good; the damage which is done to individual rights is incidental and is more often the result of needless opposition by the individual. In this matter of public lighting the right of the community to interfere is so evident that it has been one of the first subjects considered, and will be one of the first disposed of; and its priority in time will establish its disposition as a precedent for the future disposition of similar questions. There is immediate need for clear thinking and for well considered speech and action—for speech, telling the public that electric light companies desire to do business according to the golden rule, and for action plainly in conformity with the speech. I believe that this Association can appropriately speak for its membership, and that its members are willing to live up to the principles which the Association may enunciate.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, June 10th, 1898.

Gas Managers' Meetings—Employers' Liability—Revised Instructions of the Metropolitan Gas Referees.

The season for gatherings of gas engineers has commenced. Several spring meetings of district Associations have been held in various parts of the country, for the most part in anything but that genial spring weather which is associated with the month of May, by poets and others who are not held responsible for their statements. This year the pleasure of one of the excursions—that of the Midland—was marred by a carriage accident, the President being thrown to the ground and sustaining a broken collar bone. The two central Associations have issued their notices and programmes, which afford strong evidence to the effect that the last word has not yet been said about gas, and that the opinion held by some—usually those who never read a paper or join in a discussion—to the effect that gas topics are about pumped out, is utterly untrue. The literary portion of the proceedings to be held during the present month shows a freshness and vitality that will compare favorably with those of any previous year, not the least interesting feature being the appearance of one or two names, generally well known and respected in the profession, but not often met with on agenda papers.

The Gas Institute shows a healthy and flourishing condition. In the words of a once popular ditty, "It has the men and has the money too." With an existing membership of 656 all told, a ballot list of nearly 40 new members, and a cash surplus for the year of £170, the facilities for doing good and useful work are rapidly improving. This year's meeting promises to be a most enjoyable one, as it is to be held at Belfast under the presidency of the talented and genial Mr. James Stelfox, Gas Engineer to the Belfast Corporation. A reception by the Mayor, visits to the various municipal enterprises, and to many of the large industries such as ship yards, flax works, rope factories, printing works, tobacco manufactories and whisky distilleries, for which the town and neighborhood are famous, together with a day's excursion in the no less celebrated mountain districts of the North of Ireland, go to

make up an attraction that is not offered every year. The more solid portion of the programme includes a lecture on "Acetylene and its latest developments," by Prof. Vivian B. Lewes, and nine papers on various subjects. These together with the usual inaugural address will profitably occupy the allotted hours for indoor sittings. Following the example set by a well known fellow countryman who, alas! is no longer present with us to assist the business proceedings by his clear judgment and unique scholarly ability, or to enliven the after dinner periods by his ready wit and overflowing good nature, Mr. Stelfox will, in awarding the premiums for papers read at the last meeting, present the first prize to himself. One new topic, which forms the subject of a paper written by the ex president, Mr. C. S. Ellery of Bath, is the effect of the New Workman's Compensation Act which comes into force on the 1st prox. Under existing Employers Liability Acts, the insurance rates quoted to gas works were 2s. 6d. per cent., *i. e.*, per £100 per annum paid as wages. But the provisions of the new Act are so stringent, especially in granting unlimited liability as to disablement, that the rates first asked were 25s. per cent. This is now generally acknowledged to be too high, and several good offices are quoting about 20s. But even the lower figure is sufficient to show that the increase of liability is very real. The subject has occupied a great deal of attention for some weeks past and several suggestions have been made, one of the most practicable being that several gas works should combine together under one policy to cover the whole. The insurance offices, it is said, would take £100,000 annual wages at a much lower rate than £1,000, and therefore a company would do better by taking a *pro rata* share according to wages paid in a large policy, than by insuring independently. Mr. Ellery's topic is a burning question, and will be listened to and discussed as such. Mr. Green, of Preston, has been induced to come forward and speak on the "Construction and Working of Purifiers." It is well known that this gentleman has successfully put into practice some novel ideas on this important subject, which has lately excited some attention in the United States, and his utterances will be received with much interest.

The Institution of Gas Engineers, a young society that to some extent makes up in quality for its deficiencies in quantity as represented by the length of the members' roll, will meet in London. Last year the Institution visited Holland, and the hosts in 1897 will be the guests in 1898. The Institution of Dutch Gas Engineers will visit London next week, where their mental capabilities will be attended to at Beckton and East Greenwich, and their physical comforts at the Trocadero and the Crystal Palace. This international exchange of courtesies is an excellent idea. One gets some new notions from visiting his neighbor, in his own country, or by going to another part of his native land. But for a thorough all round change and mental refresher, give me a visit to another land, where one may see new faces, new dresses, hear another language and encounter commercial conditions altogether different from those amid which he has grown up. Two days are to be devoted to the indispensable "papers," and two days to visits and recreation in the company of the visitors from the Zuider Zee.

A radical change is to be made in the gas testing arrangements carried out in the district covered by the London Gas Referees. Several old acquaintances, including the sperm candle and its appurtenances, the 60 or 100-inch graduated bar, and the traveling disk carriage, are banished from the scene. In future the gas, instead of being adjusted to a regular consumption of 5 cubic feet per hour, will be made to give a uniform light equivalent to 16 candles, and the rate of consumption under this condition, as shown by the number of seconds that elapse during the consumption of ¼ cubic foot of gas as indicated by the meter, furnishes the data from which the value of the gas is to be computed. This in effect means the total abandonment of the English system of photometry in favor of the French system. While the English nomenclature is retained, the result will be arrived at inferentially, and not directly. The Referees have given a great deal of time to the subject, and no doubt have carefully verified their apparatus and satisfied themselves that the new method is a decided improvement on the old, but it is well to recognize that the new system is not a direct statement of actual observations. For example, we are accustomed to call a gas 17.5 candles that actually averages that value by direct readings from the disk, subject to corrections for pressure and temperature. Under the new system a 17.5-candle gas is one that requires a proportionately less consumption of gas than the standard quantity to give a light equal to 16 candles. This is not necessarily an objection, and it certainly seems to afford a better indication of the value of the gas in practice. The consumer does not recognize the hourly consumption, whether 5 cubic feet or 50. He wants a good light, and turns the gas up till he gets it. Assuming he uses an Argand burner, and his views as to a good light happen to fall in the neighborhood of 16 candle power, then the new method exactly represents the value of the gas to him. The substitute for the sperm candle is, it is hardly necessary to state, Harcourt's 10 candle pentane lamp, and the operations of the observer are very much simplified. No actual calculations are necessary, as the results can be read directly from a series of tables already prepared. The tests for ammonia, sulphureted hydrogen and sulphur compounds remain as before, with the exception of some modifications in detail. The aerorthometer—an instrument which gives corrections for pressure and temperature at one reading—is recognized as a standard instrument. One important innovation is the introduction of the one-twelfth cubic foot measure for verifying the meters, which is a very neat and handy modification of the bulky and costly cubic foot measure previously used. Very full instructions are given as to the preparation of test solutions, and pentane for the standard lamp, also as to the dimensions of the various pieces of apparatus, so that an intelligent workman could construct the whole set for himself, and this gives the "instructions" a value to many others besides the officials for whom they are intended. Anyone wishing for further particulars may be referred to the illustrated abstract, which includes all the novel portions, given in the *Journal of Gas Lighting* for the 31st ult. The conditions of the new test can be obtained with the existing apparatus to the extent of substituting a fixed light for a fixed consumption. The gas burner, instead of being set to 5 cubic feet per hour, can be set to 16-candle power, and the data taken from the meter instead of from the carriage index pointer.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. J. H. Enright, Superintendent of the Carthage (Mo.) Light Company, has about completed to his entire satisfaction an extensive series of improvements on the plant; in fact, the renovation amounts to reconstruction, for the scheme included new buildings to house the machinery installed, and a storage shed for the coal supplies. The apparatus put in comprised a new improved Roots exhauster, a washer, a Connelly automatic street main governor, a coil condenser and a new boiler. The Company during this month agrees to sell a gas range of any make or size at 33 per cent. less than cost to itself, and further agrees to make the necessary connections free of charge. In fact, where a service is needed the same will be laid without cost to the consumer.

A correspondent, writing under date of June 20th, says: "For eight months the proprietors of the Richmond (Ind.) Light, Heat and Power Company have had standing idle a complete 7-foot set of improved Lowe water gas apparatus constructed by the United Gas Improvement Company. The cause of this dilemma was that the gasholder was equipped with inlet and outlet pipes only 6 inches in diameter—the holder was built in 1856. The problem that confronted the management of the Richmond works was to place new inlet and outlet pipes of a diameter sufficiently large to pass the gas from the machine without interrupting the operation of the plant. As the holder tank was 25 feet deep, it seemed impossible to solve the dilemma without resorting to a complete shut down of the works; so the management worried along with its 'White Elephant.' In due time, Mr. M N. Diall, General Manager of the Citizens Gas and Fuel Company, of Terre Haute, Ind., having heard of the Richmond predicament, proposed to the Richmond folks a plan of overcoming it. He suggested that he would place in the holder two 10-inch inlet and outlet pipes, with drip boxes and pump pipes complete, without interfering in any way with the operation of the gas plant or the holder. They accepted his proposition, which he successfully demonstrated this month, greatly to the satisfaction of the Richmondites. If for any reason the inlet and outlet pipes of a holder do not satisfactorily perform their work, Mr. Diall stands ready to increase the diameter of said pipes to any size, and to perform the work in any depth of water. The Richmond example is the second one given by Mr. Diall of how to increase the diameter of inlet and outlet pipes to a gasholder without removing the water in the tank, or in any way interfering with the operation of the works while the job is underway."

The United Gas Improvement Company has been authorized to construct for the Lynn (Mass.) Gas and Electric Company a standard, double superheater set of its improved Lowe water gas apparatus, up to a per diem capacity of 750,000 cubic feet.

"W. F. G." is informed that the next regular dividend (1½ per cent.) on the capital stock of the Equitable Gas and Electric Light Company, of Utica, N. Y., is due and payable July 15th.

A CORRESPONDENT at Boston, Mass., forwards the following: "The Lawrence (Mass.) Gas Company has notified its patrons that on and after July 1st the gas rate will be reduced from $1.50 per 1,000 cubic feet to $1.30 per 1,000, and that a discount of 10 cents per 1,000 will be made on all bills paid before the 15th of each month. This concession on the part of the Gas Company was brought about by the action of the Board of Aldermen some months ago. The matter of building a municipal lighting plant was discussed at that time, but the Gas Company made such favorable concessions to the city and such favorable promises to the ordinary consumers of gas that the matter was dropped. The concessions made to the city went into effect at once, but up to the present time the rates to private consumers have remained the same. It is now evident that the Gas Company intends to live up to its promises, as indeed it has always done in the past."

AT the annual meeting of the Pawtucket (R. I.) Gas Company the following officers were elected: Directors, Lyman M. Darling, Stephen A. Jenks, Eben N. Littlefield, Frederic W. Easton and Jonathan Chace; President, Lyman M. Darling; Secretary, Edwin A. Perrin; Treasurer, Charles L. Knight; Superintendent, William McGregor; Collector, George A. Stiness. The Pawtucket *Tribune*, in reporting the election, had the following further comment on the result: "The re-election of Mr. McGregor as Superintendent is a deserved compliment to that gentleman's business ability, this being his fifth year as Superintendent of the Company. During this time the efficiency of the Company's service has been brought, through Mr. McGregor's efforts, to a degree of excellence that is equalled in few cities and excelled by none. The treatment accorded patrons is so kindly and courteous that the Superintendent has made friends for the Company in every walk of life. The business of the Company has increased to a considerable degree during the past year, and this is particularly true at this time, when the number of gas stoves and ranges in use is more than double that of last year. This is directly traceable to the Superintendent, as he made great personal efforts to secure a popular lecturer to point out the advantages of gas for cooking, which course has been of equal benefit to the Gas Company and to the ladies who attended the lectures."

THE Cable Gas Company has been organized by Messrs. Noble Bennett, L. F. Curtis and L. P. Giddings. It is capitalized in $15,000, and its purpose is: "The manufacture of gas of all kinds and its sale and distribution at any and all points in the town of New Milford, for illumination, heat and any and all other purposes; the acquiring, owning, holding, leasing and controlling any property necessary or convenient for its purposes, including real estate, letters patent and rights under the same, and the transaction of any other business connected with or incident to the manufacture, sale and distribution of said gas."

NEW MILFORD is a post village in a similarly named township of Litchfield county, Conn. It is situated on the Housatonic river and on the Housatonic Railroad, at a point 14 miles north of Danbury and 35 miles northwest of Bridgeport. It holds several factories, the principal manufactures being paper, boots, buttons and hats. The population of the township is about 6,400.

ABOUT a fortnight ago, Master-in-Chancery, Mr. S. H. Lewis, sold under foreclosure, at the suit of the Farmers Loan and Trust Company, all the franchises and stock of the Salt Lake and Ogden (Utah) Gas and Electric Light Company and the Union Power and Light Company. The property was knocked down to the Union Power and Light Company at its bid of $200,000.

THE Directors of the Lebanon (Pa.) Gas Company have named Mr. L. E. Weimer as President of the Company, vice the late Mr. George H. Reinoehl.

IT is said that Mr. W. T. Morris proposes to establish a gas works in Newark, N. Y. A franchise for such an undertaking was granted two years ago to local parties.

THE Hartig Standard Gas Engine Company has been incorporated by Messrs. F. W. Harrington, J. W. Godfrey and C. H. Hodges. It is capitalized in $45,000, and the Company proposes to operate in this city.

MR. GEORGE FOCHT, proprietor of the George Focht Iron Works, of Hoboken, died at his home in that city on the morning of June 19th. He was noted in the gas trade of the United States as a successful manufacturer of self-dumping coal buckets, tipping barrows, drawing rakes, charging scoops, etc. He was in his 76th year. Two daughters and three sons survive him.

AS is well known, the United Gas Improvement Company is making many changes on its generating and purifying plant, at the 25th Ward and Point Breeze stations of the Philadelphia works. At the first named station the betterments include a scrubber house, 45 feet wide by 120 feet long, and a purifying house 86 feet wide and 180 feet long. At the Point Breeze station the construction provides for a boiler and engine room 55 feet wide and 220 feet long; a condenser building, 40 feet wide and 105 feet long; a purifying house, 86 feet wide and 180 feet long; a generator house 100 feet wide by 184 feet long; and a meter house, with additions for exhaust and valve room, having a width of 70 feet and a total length of 223 feet. All of these buildings are to be of steel frame construction, with brick side walls and slate roofs, supported on metal purlins carried by clear span trusses. All the structural steel work for this extensive plant is being furnished by the Berlin Iron Bridge Company, of East Berlin, Conn.

MR. JOHN HOLMES is said to be considering the advisability of constructing a gas works at Boone, Ia. From our point of view the named place does not offer a very inviting field for an investment of the nature indicated.

MR. ALLAN MCMILLAN, who at one time was largely interested in the La Crosse (Wis.) Gas Light Company, died at his home in La Crosse about a fortnight ago. He was in his 53d year.

THE St. Louis (Mo.) *Republic*, of recent date, had this to say: "A bill proposing to pay $9,500 per year for work that the Supervisor of City Lighting (Mr. O'Reilly) has always been able to do in his leisure moments, has been introduced in the House of Delegates, by Delegate W. H. Ritter, of the 24th Ward. The measure contemplates adding to the list of city officials a gas and electric light inspector whose duty it shall be to inspect, at the request of consumers, gas and electric meters. The salary attached to the position is put at $3,000 per year; also a chief deputy at $2.000 per year; a bookkeper, at $1,800 per year, and three clerks at $900 each per year. It shall be the duty of the inspector under the provisions of the bill to inspect meters upon application from consumers. If the meter proves faulty the inspector must notify the Company supplying the illuminant, and if the meter is not removed within 24 hours the Company shall be deemed guilty of a misdemeanor and subject to a fine of $10. If the meter proves correct, the applicant for inspection must pay the inspector $1. Meters that do not vary more than 1 per cent. are to be considered accurate. All money received from inspections is to be deposited in the City Treasury. The ordinance provides for the repeal of the existing ordinance, which authorizes the Supervisor of City Lighting to inspect meters at the request of consumers. Supervisor O'Reilly has always been able to attend to the work of inspection in connection with his other duties."

THE authorities of Camden, N. J., have awarded a contract for the public lighting of that city to the Camden Gas Light Company. The prices agreed on are: For ordinary gas lamps, $20 per lamp per annum; for Welsbach lamps, single burner, $24 per lamp; Welsbach lamps, double burners, $28 per lamp. We understand that the Welsbach lamp will be largely used.

MR. EDWARD C. WHITE has been appointed Superintendent of the Asbury Park division of the Consolidated Gas Company, of New Jersey. He succeeds Mr. C. D. Strong, who, as we noted before, replaced Mr. Paul Doty in the General Managership of the Company. Mr. Doty is now in charge at Grand Rapids, Mich.

THE hearing on the petition of the Massachusetts Pipe Line Company, for permission to issue capital stock to the amount of $1,000,000, was begun before the Massachusetts Board of Gas and Electric Light Commissioners last Wednesday.

THE gas rate at Los Angeles, Cal., has been reduced to $1.65 per 1,000 cubic feet.

THE 38th annual meeting of the German Association of Gas and Water Engineers will be held at Nuremberg, June 29th and 30th and July 1st, under the Presidency of Herr L. Korting, of the Hanover gas works.

THE AMERICAN GAS LIGHT JOURNAL

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EDITORS.

CHAS. E. SANDERSON,

MANAGER.

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AGENTS:

MONDAY, JUNE 27, 1898.

A Washing Plant for Anthracite Waste.

The annual report of the Girard Estate gives a description of a plant for washing the culm or waste piles on the Rees tract owned by the Estate. This plant was erected by Benneville F. Berthelot, a lessee from the Estate, last year. The plant consists of three buildings, the screen building, the boiler house and the engine house. Besides the machinery in the houses there are scraper lines for bringing in the material of the culm banks and for carrying away the refuse, water pipes and pumps for supplying water to boilers and to jigs and screens for washing the coal.

The screen building has a frontage along the railroad of 100 feet, is 32 feet deep and 64 feet high, contains a scraper line to bring the material from the culm banks, another to carry away the refuse, a large revolving slush screen in which the material from the banks is washed and the coal separated from the refuse, a set of elevators to carry the coal from the slush screen to the top floor of the building, two sets of breaking rolls, five shakers to separate the coal into different sizes, four sets of double jigging machines with stocking bins for chestnut, pea, buckwheat and rice coal.

The boiler house is 44½ by 23½ feet, and contains two tubular boilers 5½ by 16 feet. The engine house is 26 feet by 22½ feet, containing engine and shafting for transmitting the power by hemp ropes to the breaking and scraping machinery.

The plant was put in experimental operation on July 1, 1897, and during the month was adjusted as required, and for the last five months of the year has been in continuous operation. The coal shipped has been 17,897 tons, principally of the smaller sizes, pea, buckwheat and rice. What large coal can be saved from grinding down is now separated and shipped as stove and chestnut. The proportion of each size made this year has been: Chestnut coal, 2.02 per cent.; pea, 28 50; buckwheat, 37.32; rice, 32.16 per cent. The coal used in operating the plant was 5.6 per cent. of the shipment to market, all of rice coal.

The Market for Gas Securities.

The market for city gas shares was dull and weak since time of last writing, although, on the whole, prices were fairly well maintained. Consolidated to-day (Friday) came in at 196½, and the variation in price at the close did not amount to 1 per cent. Mutual and New Amsterdam common were dull and strong. Brooklyn Union is 124 bid, and Peoples, of Chicago, was hammered down to 95 and a fraction. Insiders are responsible for the juggling. Consolidated, of Baltimore, is going up steadily. The bid is 63½.

The U. G. I. Company's regular quarterly dividend of 2 per cent. is payable the 15th prox. The Cincinnati Gas Light and Coke Company's quarterly dividend of 2½ per cent. is payable Saturday. At auction, some days ago, a small lot of York (Pa.) stock was sold, at an average of 157.25 per cent. Those supposed to be in the know predict that a sharp upward movement in Bay State gas is imminent. We hope so.

Gas Stocks.

Quotations by Frederic B. Cochran & Co., Brokers and Dealers in Gas Stocks,

20 AND 22 BROAD STREET, NEW YORK CITY.

JUNE 27.

☞ All communications will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$36,230,000	100	196	196
Central	500,000	50		..
" Scrip	220,000	..	100	.
Cental Union, Bonds, 5's	3,000,000	1,000	99½	100
Equitable	4,000,000	100	206	215
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	500,000	100	325	335
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
New Amsterdam Gas Co.	13,000,000	100	30¼	30¾
Preferred	10,000,000	100	72¾	73
Bonds, 5's	11,000,000	1,000	100¾	101⅛
Northern	150,000	50	..	
" Bonds	150,000	1,000	..	
Northern Union, Bonds, 5's	1,250,000	1,000	94½	95½
New York and East River	5,000,000	100	81	83
Preferred	2,000,000	100	112	115
Bonds 1st 5's	3,500,000	1,000	110	112
" 1st Con. 5's	1,500,000	..	105	107
Richmond Co., S. I.	348,650	50	70	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	139	141
Preferred	5,000,000	100	155	160
Bonds, 1st Mortgage, 5's	1,500,000	1,000	112	114
Yonkers	299,65	500	130	.
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	124	..
" " Bonds (5's)	15 000,000	1,000	115	..
Bay State	50,000,000	50	3⅝	3¾
" Income Bonds	2,000,000	1,000	..	75
Boston United Gas Co.—				
1s Series S. F. Trust	7,000,000	1,000	..	92
2d " " "	3,000,000	1,000	70	..
Buffalo City Gas Co.	7,000,000	100	23½	25
" " Bonds, 5's	7,000,000	1,000	90	91
Central, San Francisco	2,000,000	..	90	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Columbus	1,000,000	.	89	91
1st Mortgage	1,085,000	..	101	103½
Consumers, Jersey City	2,000,000	100	75	80
" Bonds	600,000	1,000	100	103¾
Cincinnati G. & C. Co.	8,500,000	100	205	205½
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	11,000,000	100	63⅛	64
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	..
Consolidated G. & E. Co.'s., Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit	4,000,000		58	58½
" Con. Bonds	4,312,000	..	96¾	98
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	75	80
" Bonds	2,000,000	..	88	91
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	115	125
" Bonds, 6's	2 650,000	..	106	107
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind.	1,000,000	100	78	88
Bonds	1,000,000	1,000	90	91
Louisville	2,370,000	50	..	..
Laclede, St. Louis	7,500,000	100	48¾	49
Preferred	2,500,000	100	91	93
Bonds	2,084,400	1,000	104½	105
Montreal, Canada	2,000,000	100	200	..
Newark, N. J., Gas Co.	1,000,000	..	200	220
Bonds, 6's	4,000,000	..	128	130x
New Haven	1,000,000	25	252	..
Oakland, Cal.	2,000,000	..	53⅛	54
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	95¾	96
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,00	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	94	94½
St. Paul Gas Light Co.	1,500,000	100	49	51
1st Mortgage 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	2,500,000	25	17	18
Bonds	1,000 000	..	94	97
Washington, D. C	2,000,000	20	250	..
Western, Milwaukee	4,000,000	100	88	90
Bonds, 5's	3,556,000	.	102	104
Wilmington, Del.	550,000	50	200	

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DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., 815 DREXEL BUILDING, PHILA., PA., June 23, 1898.

The Directors have this day declared a quarterly dividend of 2 per cent. (one dollar per share), payable on July 15, 1898, to stockholders of record at the close of business June 30, 1898. Checks will be mailed.

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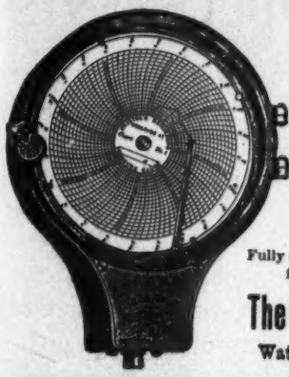

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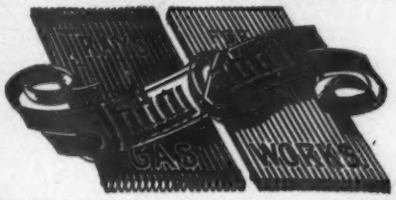

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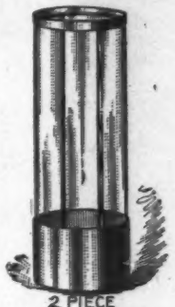

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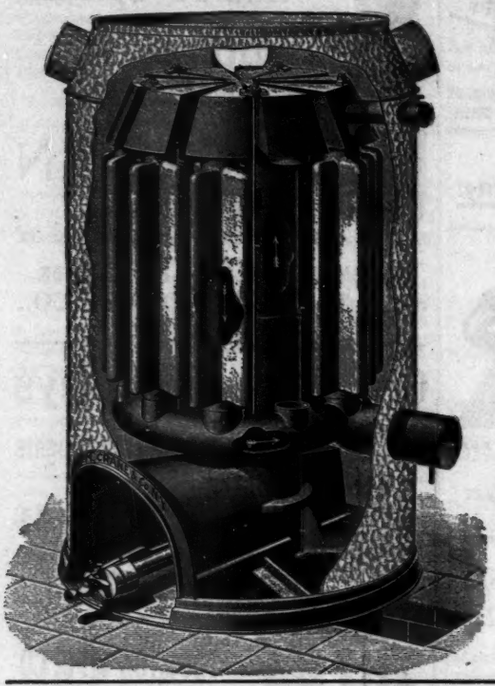

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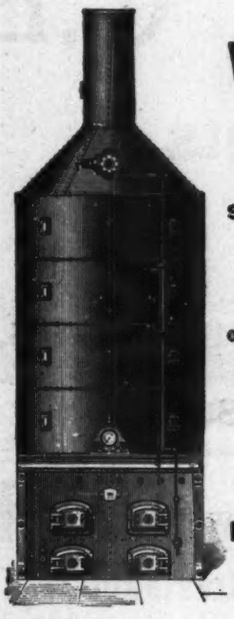

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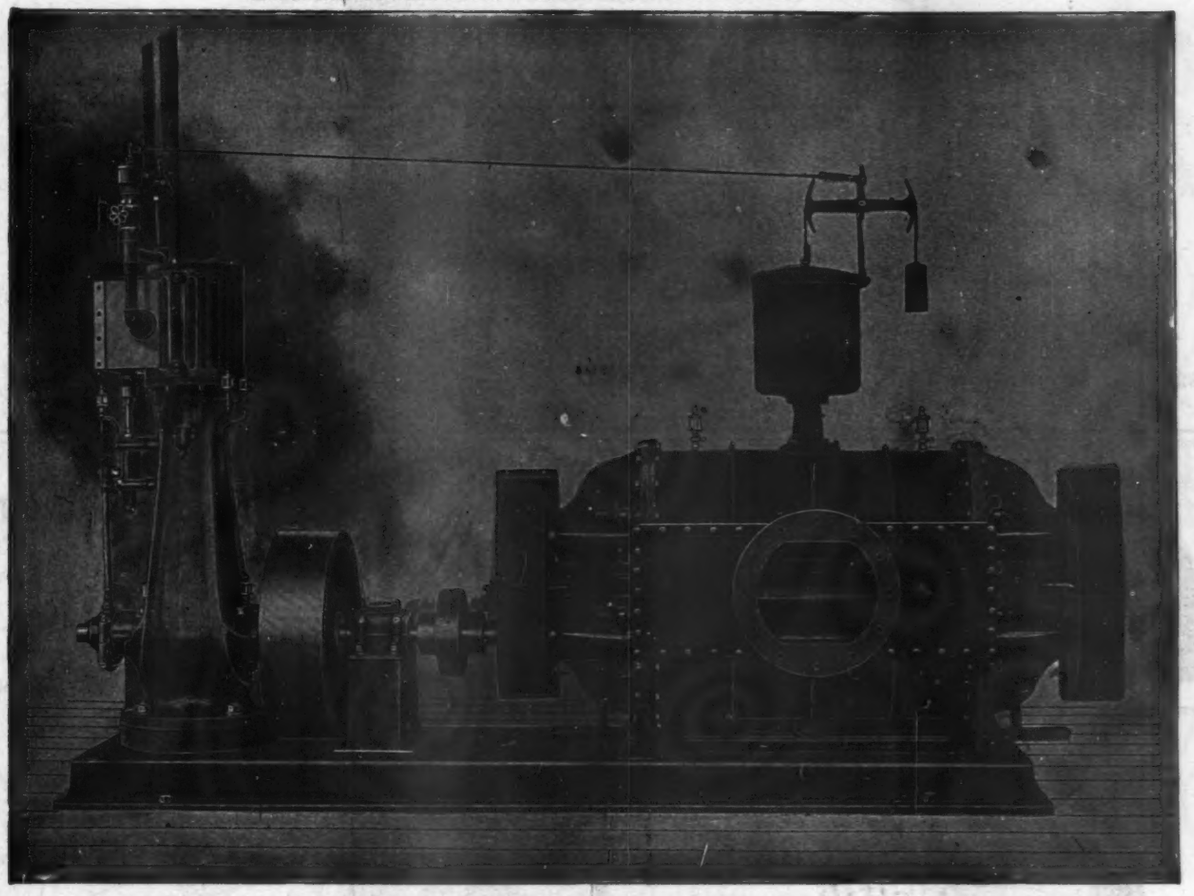

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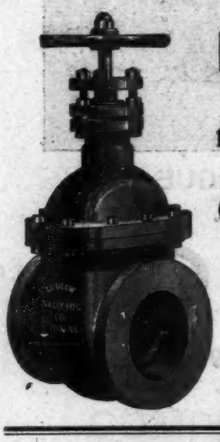

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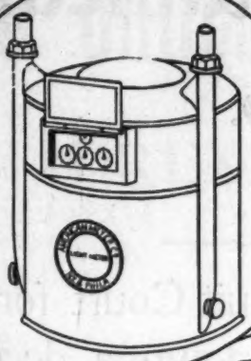

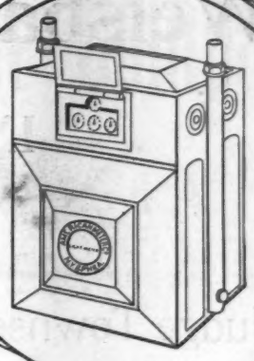

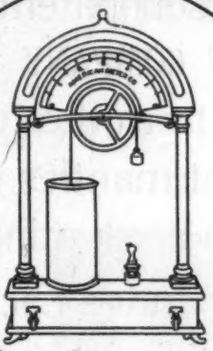

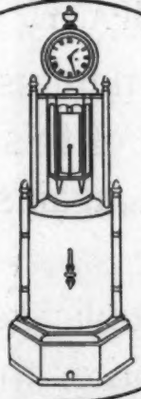

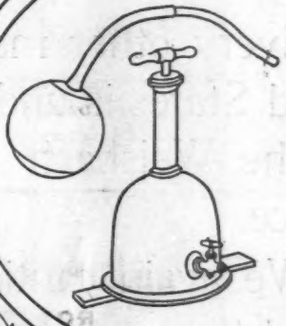

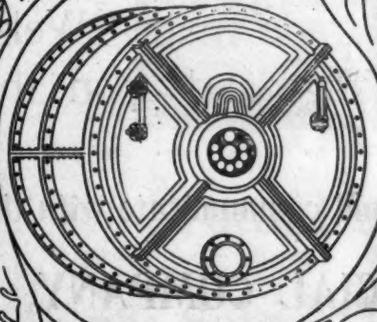

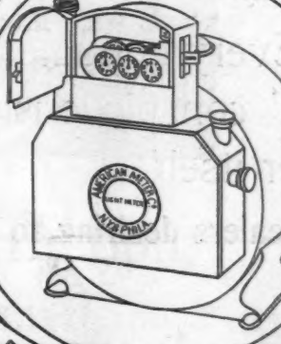

PUBLIC LIGHTING TABLE.

JULY, 1898.

Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Fri.	1	1.50 AM	2.30 AM	7.30	3.15
Sat.	2	No L.	No L.	7.30	3.15
Sun.	3	No L. FM	No L.	7.30	3.15
Mon.	4	No L.	No L.	7.30	3.15
Tue.	5	8.00 PM	10.00 PM	7.30	3.15
Wed.	6	8.00	10.30	7.30	3.15
Thu.	7	8.00	11.00	7.30	3.15
Fri.	8	8.00	11.20	7.30	3.15
Sat.	9	8.00	11.50	7.30	3.15
Sun.	10	8.00 LQ	12.10 AM	7.30	3.15
Mon.	11	8.00	12.40	7.30	3.15
Tue.	12	8.00	1.20	7.30	3.15
Wed.	13	8.00	2.00	7.30	3.15
Thu.	14	8.00	2.40	7.30	3.15
Fri.	15	8.00	3.40	7.30	3.15
Sat.	16	8.00	3.40	7.20	3.15
Sun.	17	7.50	3.50	7.20	3.15
Mon.	18	7.50 NM	3.50	7.20	3.15
Tue.	19	7.50	3.50	7.20	3.15
Wed.	20	7.50	3.50	7.20	3.15
Thu.	21	7.50	3.50	7.20	3.15
Fri.	22	7.50	3.50	7.20	3.15
Sat.	23	8.30	3.50	7.20	3.15
Sun.	24	9.00	3 50	7.20	3.15
Mon.	25	9.30	3.50	7.20	3.15
Tue.	26	10.00 FQ	3.50	7.20	3.15
Wed.	27	10.40	3.50	7.20	3.15
Thu.	28	11.30	3.50	7.20	3.15
Fri.	29	12.40 AM	3.50	7.20	3.15
Sat.	30	1.50	3.50	7.10	3.30
Sun.	31	No L.	No L.	7 10	3.30

TOTAL HOURS LIGHTING DURING 1898.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	210.40	January	423.20
February	186.40	February	355.25
March	181.20	March	355.35
April	166.10	April	298.50
May	156.40	May	264.50
June	144.30	June	234.25
July	147.30	July	243.45
August	157.10	August	280.25
September	169.50	September	321.15
October	186.00	October	374.30
November	204.30	November	401.40
December	218.30	December	433.45
Total, yr.	2129.30	Total, yr.	3987.45

Welsbach Patent Sustained.

INJUNCTION GRANTED.

Judge Townsend, in the United States Circuit Court for the Southern District of New York, has handed down a decision sustaining the Welsbach Light Company's Rawson patent, and adjudged **THE SUNLIGHT INCANDESCENT GAS LIGHT COMPANY** to be an infringer. This Company has been enjoined from the further use of its method of manufacture of incandescent mantles or the sale or use of the same, and ordered to render an accounting.

A further decision has been handed down by Judge Lacombe in the United States Circuit Court, granting a motion for a similar injunction against **THE REX INCANDESCENT LIGHT COMPANY.**

Every other manufacturer of incandescent mantles in the United States is under these decisions an infringer of this patent, and the Welsbach Light Company will proceed against them at once.

We again caution gas companies and the public generally against the purchase of any incandescent mantle other than that made and sold by the Welsbach Light Company or its agents.

Every genuine Welsbach lamp has the trade mark "Welsbach" conspicuously printed upon the package and upon the burner itself.

Dealers desiring to handle the genuine article should communicate with the

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The United Gas Improvement Company,

DREXEL BUILDING, PHILA., PA.

The Standard Junior,

The Standard Double Superheater,

LOWE WATER GAS APPARATUS.

Total Built and under Construction,

281 Sets—Daily Capacity, 179,850,000 Cu. Ft.

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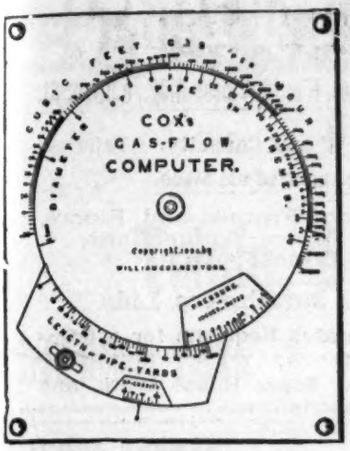

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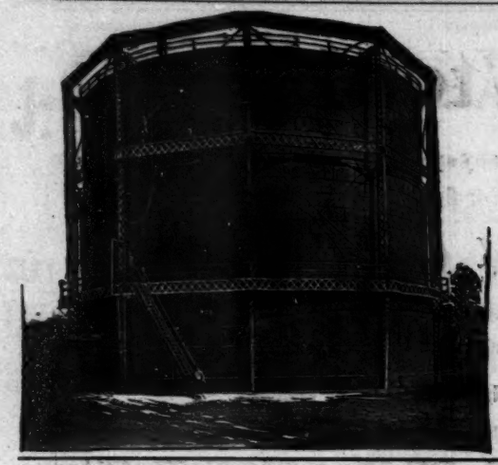

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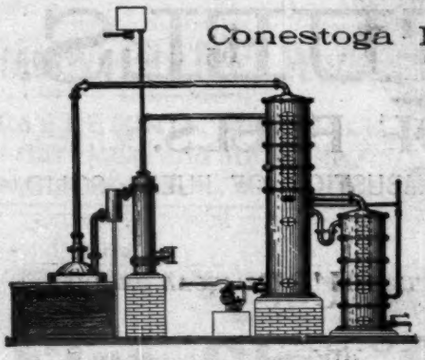

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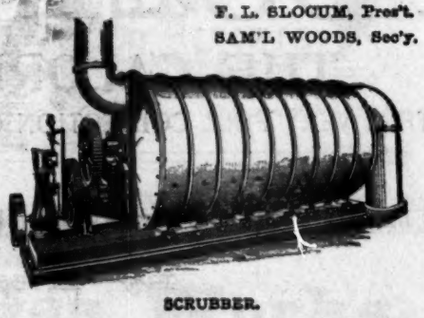

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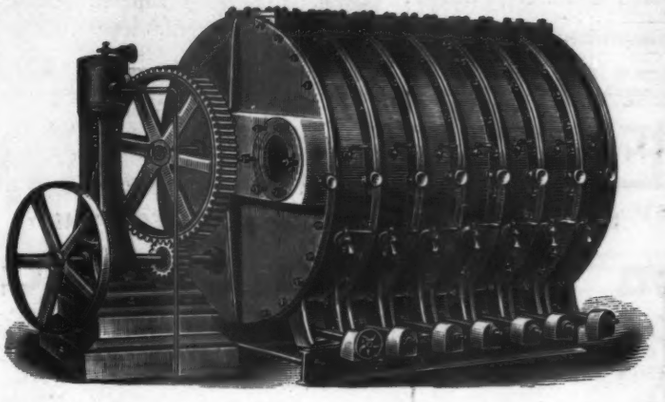

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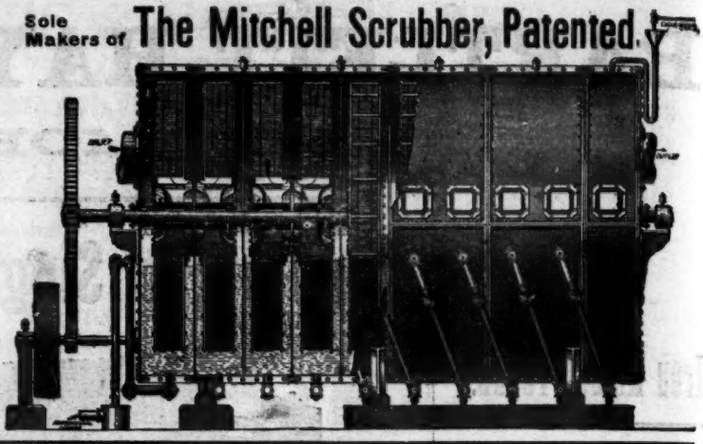

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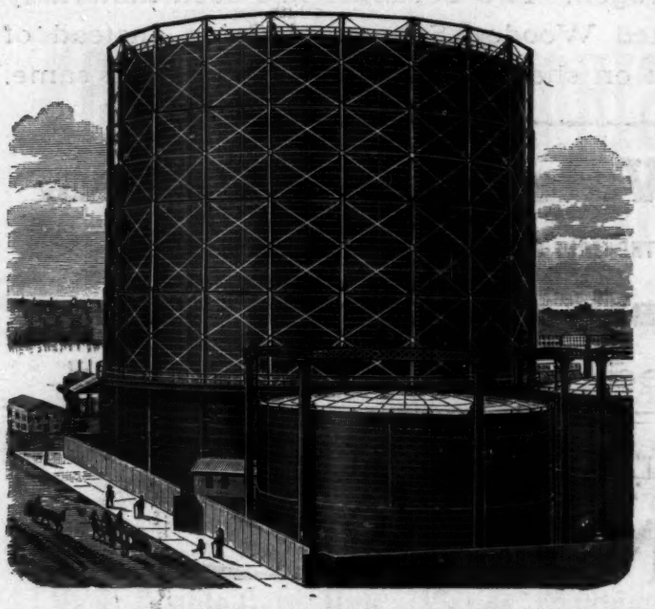

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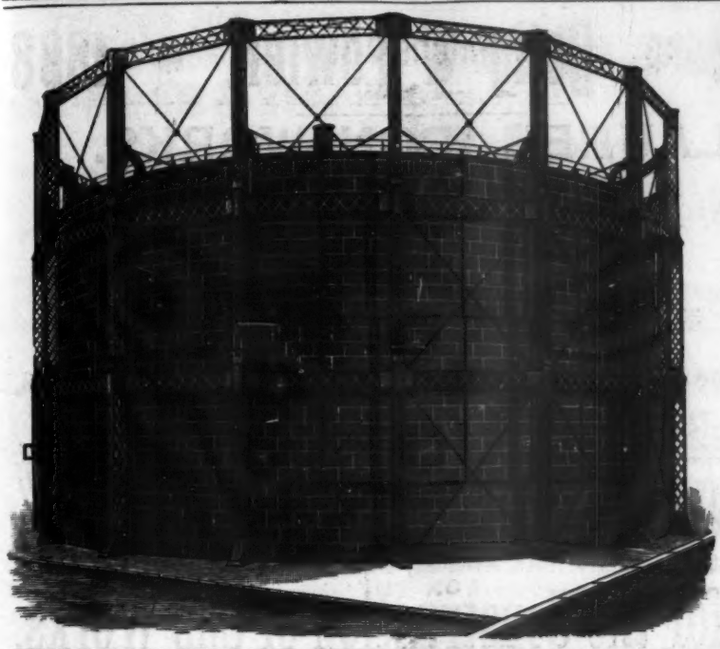

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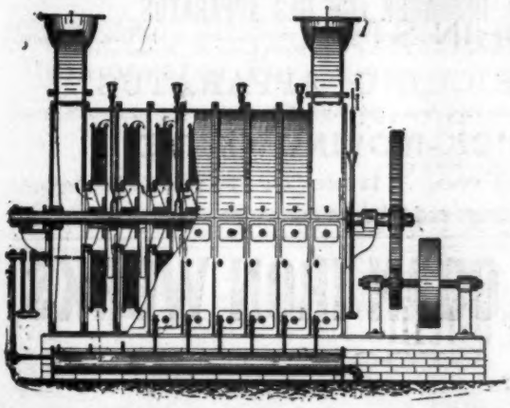

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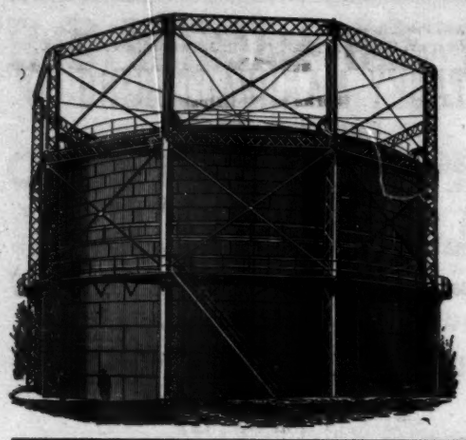

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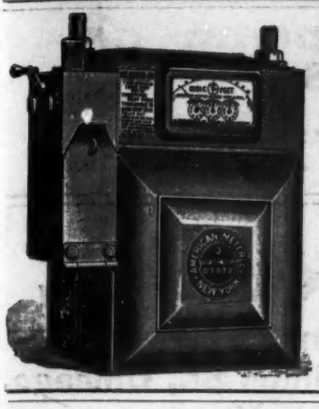

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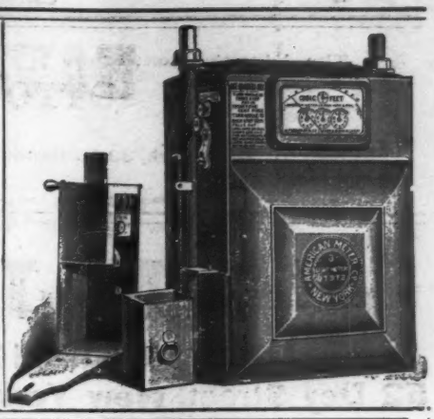

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